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THE APPLICATION OF ELECTRIC POWER ON TRUNK-LINE RAILWAYS.

By George Forbes.

IN accepting the invitation of the editor of THE ENGINEERING MAGAZINE to write an article upon electric traction with special reference to its probable extension to trunk lines, it is not the writer's purpose to instruct engineers in the duties of their profession, or to suggest to manufacturers any new directions in which to work, but simply to give those who are financially interested in railways the results of disinterested and careful study and extensive calculation. After casting a retrospective glance over what has been accomplished, he will endeavor to indicate the directions in which electric traction is advancing, and to state in broad and general terms the conclusions that he has arrived at as to the cost of works and facility of carrying them out.

In dealing with this subject, it must be borne in mind that circumstances differ. The street railway has developed to a marvellous extent in America, whereas in some European countries it has not found general favor. The cause of this lies largely in the differing circumstances. Countries are also affected in varying degrees by the amount of their suburban traffic, while the introduction of electric traction must also depend on the amount of underground communication in large towns. And other special features arise, such as the facility of obtaining water power for generating electricity or the difficulty of getting water for the generation of steam.

The first town to be thoroughly equipped with electric street railways was Richmond, Virginia (in 1878, on the Sprague system), and from that date their development has been by leaps and bounds.

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Moreover, it has been continuously in the same direction, and, while competitive systems have at various times come forward and may prevail at some future time, yet the overhead trolley system has so far almost monopolized the field. The consequence is that the general methods of working have remained tolerably uniform, although there have been decided improvements in the details of machinery. In the United States, where this development has been most rapid, the systematizing of methods has become as complete as in the case of steam railways, and this applies to construction as well as equipment. The figures showing the present state of development are startling to those who have not yet realized them. It is impossible at present to get details of what has been done up to the present moment; the following figures are for 1895, up to which date sufficiently correct estimates have been prepared. At the end of 1895 in the United States there were 12,583 miles of electric street railways in operation. The capital invested in electric street railways at the same time was $1,400,000,000; the net gross receipts, $164,250,000; expenses, $113,500,000; number of passengers carried, 3,000,000,000. These figures alone are sufficient to impress anyone accustomed to deal with the development of large industries.

A good many years ago the writer was in attendance at a meeting of electrical engineers in New York, and, after numerous statements had been made about the progress of electric street railways in the United States, he was invited to give information as to what was being done in England. He then confessed that progress in electric tramways on the other side of the Atlantic had been very slow, but he described the principal development of electric traction which had taken place, and characterized it as being on new lines, saying that possibly this single instance might turn out to be almost equal in value to the street-railway work which had already been described. He referred to the City and South London Railway, which cannot be looked upon as a tramway in any sense of the word, but is a solid railroad properly constructed, its great distinction from the electric tramways being in the fact that the trains were hauled by electric locomotives. Several of his brother engineers in America grasped this fact at once, and were quite prepared to admit that, in the development of the electric locomotive, of which this was the first step, there might be a future worthy of comparison with what had been done in the propulsion of individual cars on street tramways. No assertion was made that the adoption of the locomotive was opening a new era; the statement was simply that the London experiment was one of great interest to all electrical engineers who wish to have a hand in moulding the future of this department of engineering. Since

that date electric locomotives have been used on many railways. The facts are not generally known to the public, and it is not out of place here to refer to special cases.

The Niagara Falls Park and River Railway. This railway is 12 miles long, of double track, resembling in every way the standard adopted by the Canadian Pacific Railway. The maximum speed attained is 30 miles an hour. Trolley wires are used. There are two motor houses: one at the falls, worked by water power; the other a small auxiliary station at the Queenstown end of the road, with steam plant. There is 15 minutes' headway between cars, the average speed, including stoppages, being 13 miles an hour. Locomotives, in the ordinary sense of the term, are not used, but twenty-two motor cars supply this service, and are followed by trailers, etc. Some of the cars, when fully loaded with passengers, weigh more than twenty tons. There are eight regular stopping-places along the line, furnished with platforms.

This railway has been referred to, not because of any special merit which it possesses, but because it is not a street railway, and because it shows a method of working. In fact, reference is made to it partly to draw attention to the extremely objectionable feature of it. When water power was available, it was not good policy to use steam power at a distance of 12 miles. Of course, if the electric pressure were only 500 or 600 volts, there would be a great waste of energy or an enormous expenditure of copper in carrying the current to even that short distance; but there would have been no difficulty in transmitting electrical power at high pressure, transforming it down, and converting it into a continuous current. This would have saved nearly the whole expense of working the steam plant. It is important to give attention to this matter of the use of water power on trunk railways. There has been an absurd hesitation to undertake the transmission of power to great distances. If engineers who have had experience in the transmission of power and in the conversion of alternating into continuous currents would look into this question, they would be convinced that where water power is available it is generally economical to transmit electrical power hundreds of miles for working railways. As an example, it can be proved that, if the railway companies of Scotland were to combine to work their trunk lines by means of electric locomotives, the electric current being developed by the water power which exists in that country, then the whole of that service might be carried on without the use of steam locomotives.

Another lesson to be drawn from a careful consideration of the subject is that the waste of coal on steam locomotives is not by any means compensated by the extra cost and loss of power in electrical trans-

mission. Estimates have been prepared which show that not only is the cost of copper prohibitive, but that the efficiency of the electric system renders the consumption of coal with stationary engines about as great as with locomotives. This is certainly not the case. The cost of electric transmission, when properly effected, is not comparable with what it is as calculated on the lines adopted in the past; and, on the other hand, the efficiency of dynamos and motors has not been sufficiently considered in street-railway practice in the United States. A very large part of the success of the Liverpool Overhead Railway is due to the high efficiency of the electrical machinery.

The Baltimore Tunnel. This is a section of the Baltimore & Ohio Railway which it was found desirable to work electrically. The tunnel runs under Baltimore city, and is 7,339 feet long, 27 feet wide, and 22 feet high. There is a steady grade of 0.8 per cent. from south to north. The passenger trains are pulled through the tunnel, and the freight trains are pushed the entire distance, steam locomotives in the latter case assisting them in the open. The calculations were for a maximum weight of 500 tons per passenger train, including locomotive, with a speed of 35 miles an hour; for freight trains, a weight of 1,200 tons and a speed of 15 miles an hour. The locomotives have four gearless motors, two to each truck. All the freight and passenger trains are run through the tunnel by electric locomotives. The following are examples of what has been done on this line. A train weighing 1,125 tons was hauled up a gradient of 42 feet to a mile by the electric locomotive. At the end of one minute the train was moving at 10½ miles an hour. In another case, with a total weight of 1,068 tons, the electric locomotive gave a drawbar pull of 25,000 pounds, as measured by a dynamometer; with a speed of 11⅛ miles per hour and a train of 1,600 tons the drawbar pull was 45,000 pounds. On another occasion a train weighing 1,900 tons was started in the tunnel, and the maximum drawbar pull was 60,000 pounds at 12 miles per hour. This case is cited as showing that electric locomotives are capable of doing all that can be done by steam locomotives. The first locomotive supplied has been running steadily since August 4, 1895.

Nantasket Beach Electric Railway. This electric railway is a branch of the New York, New Haven & Hartford Railway. It is 7 miles long, with some sharp curves, and there is a gradient of 34 feet to the mile. There are stops about every quarter of a mile. Motor cars are used with trailers, with a drawbar pull amounting in some cases to 8,000 pounds. Further extensions of this railway in the same direction have been made, with the use of a third rail between the ordinary rails as a conductor for electricity. These exten-

sions are from New Britain to Berlin and from Hartford to New Britain. There are twenty-two grade-crossings, at each of which the third rail is replaced by underground cables. This electric railway is cited here as the first instance of the supplanting of steam by electricity on a standard American railway.

Liverpool Overhead Railway. The length of this line is 6¾ miles, of standard gage. A third-rail conductor is laid between the ordinary rails. There are two motors on each train, one at each end, each motor being of 40 h. p. This line was designed with the utmost care. The machinery was not taken from stock patterns, but specially designed to give high efficiency, the benefits from which have been thoroughly appreciated. This line deserves consideratlon as comparable with the one next to be considered, and as illustrating the advantage of applying motive power to the wheels of the train instead of to a locomotive, wherever possible. It can be shown that the greatest advantages are attained when the electric power is applied to every axle of the train, and this is the direction in which engineers ten or fifteen years ago expected that electric traction on railways might be developed. The inconveniences and expense, however, of replacing the whole of the old rolling stock by new, and the unsuitability of the system generally to existing lines as worked by steam, have rendered the use of a locomotive of the utmost importance in all applications to railroads where steam has been used.

The City and South London Electric Railway. This railroad has 3¼ miles of double line. It is driven by electric locomotives, each of which has two motors, giving in all 100 h. p. A third rail is used for the electric conductor. This was the first electric railway introduced in London, and its operation has been studied by engineers and railroad men with great interest. A few figures are given below for the two electric railways last mentioned. Some comparisons with the Metropolitan District Railway are also introduced, excluding the goods trains, as the other railways are only for passengers. The figures are as follows:

City and South London Electric Railway.

Miles travelled by passenger trains		451,609
Cost of locomotive and generating plant	£11,407	
Repairs and renewals of carriages	£ 874	
		£12,281

or $\frac{12281}{451609}$ = £.027, or 6.48d. per train-mile.

Liverpool Overhead Railway.

Miles travelled by passenger trains		632,763
Cost of locomotive power (including stationary engines)	£ 9,448	
Repairs and renewals of carriages	£ 456	
		£9,904

or $\frac{9905}{632763}$ = £.016, or 3.84d. per train-mile.

Metropolitan District Railway.

Miles travelled by passenger trains		1,369,999
Cost of locomotive power (including stationary engines)	£54,556	
Repairs and renewals of carriages	£12,793*	
		£67,349

or $\frac{67349}{1369999}$ = £.049, or 11.76d. per train mile.

In connection with these figures it should be noted: (1) that the District Railway trains are approximately four times the weight of those of the other two (electric) lines, the weights, according to Messrs. Greathead & Fox's paper, published in the Minutes of the Institute of Civil Engineers, Vol. 117, p. 67, being as follows:

City & South London Railway.			Liverpool Overhead Railway.			Met. District Railway.		
T.	Cwt.	Qrs.	T.	Cwt.	Qrs.	T.	Cwt.	Qrs.
37	7	0	38	5	2	157	10	0

(2) that, if the train mileage for the two electric railways was increased to that of the Metropolitan District Railway, the figures for cost of locomotive power would doubtless be reduced.

The remarkable economy of operating the Liverpool Overhead Railway has surprised all those whose experience in electrical traction has been limited to street railways. The reasons for this excellent performance lie partly no doubt in the cheapness of fuel and of labor,

* The Metropolitan District Railway has, out of 409 vehicles, 41 carriages and wagons other than those used for conveyance of passengers. Therefore the figures given in the published returns for repairs and renewals are too high by, say, one-tenth. The figure given above under this heading has been obtained by reducing that given in the returns by this amount.

but far more in the good quality of the track and the care taken in designing and supplying efficient machinery.

The examples chosen must not be looked upon as an exhaustive list of cases where electric traction has been successful in competition with steam. They are typical cases, each illustrating some point which it is desirable for the public interested to have knowledge of. There has been no example of a long trunk line worked electrically, but, from the examples already given, it can be taken as thoroughly established that this is not due in any way to want of capability in the electric locomotive. The reason why trunk lines have not been worked by electricity is that, rightly or wrongly, those who have had the matter to decide have considered the cost of transmitting electric power too great. There would be nothing experimental in carrying out such a work, and the estimates of cost can be made out with the greatest accuracy. In an article like the present, intended for business men, as well as technical experts, such estimates should not be introduced; but it is necessary to draw attention to the fact that, in a great deal that has been written on the subject, it has been assumed that the electric pressure upon the feeders is only some 600 or 700 volts. Without assuming to advance any new idea upon the subject, the writer may cite as indisputable the fact that the feeders may be supplied with current at 10,000 volts or more, which may be in the form of continuous current, but which is more manageable as an alternating current. At different stations along the line it would be reduced in pressure by means of transformers, and converted into continuous current by means of a commutating machine. It is in this point that machinery for working the proposed system has been the least developed. The commutating machine now on the market, introduced first by Mr. Shuckert in Germany, and applied in various factories at the Niagara works, is usually called a rotary transformer. It does its work admirably, but it is expensive, cumbrous, and requires continual attention. This last fact renders it impossible to lay such machines along a trunk line at distances of a few miles. But I have prepared the designs for a transforming and commutating machine free from all the defects referred to, which can be manufactured at small cost. For years I have impressed upon manufacturers the desirability of such a machine, and it is only a matter of time when they will find that it is to their own interest to provide it. Viewed in the light of the adoption of very high electric pressures, the cost of transmitting the power electrically is not at all the serious matter that it has been considered, but, in spite of this fact, human inertia may prevent rapid progress in the direction of working trunk lines electrically. After wide experience and a laborious study of the whole question, the opinion of the present

writer is that, as a rule, electric locomotives, with the power developed by steam, would, if the work were carried out on proper lines, be cheaper than the steam railroad up to a distance of between 40 and 50 miles from the power station. If water power were available for generating the electricity, the distance at which steam power would begin to be the cheaper on a busy line is several hundred miles. These statements are the result of calculations with coal at a dollar and a half per ton. This economy arises from the well-known fact that in the best trial tests of locomotives five pounds of coal are required for the h.-p. hour, and from the fact, equally well known, that so good a result is rarely attained, in nearly every case the consumption of coal being several times as much as that indicated. These conclusions, however, do not give much encouragement for the substitution of electricity for steam, except in special cases. A time may come when special railroads will be built over long distances to be worked electrically, and in that case there are advantages of a totally different character which will favor electricity, depending upon the fact that the locomotive will be abolished and power applied to every axle of the train.

In the year 1881, the present writer, in the course of some correspondence from the Paris Electrical Exhibition to the London *Times*, drew attention to the possibilities of electric traction on railways. That article was really the summary of a lecture which had been delivered before Anderson's College, in Glasgow, in 1879. In that article he drew attention to the remark made by Captain (now Sir) Douglas Galton, in the concluding paragraph of his report on experiments conducted by himself and Mr. Westinghouse on the air-brake when used with trains going at high speed. In that report Sir Douglas Galton said: "The advantage which thus evidently ensues from utilizing the adhesion of every wheel of a train suggests the further consideration as to whether it would not be a more scientific arrangement, as well as more economical in regard to the permanent way of railways, to utilize the adhesion of every wheel of a train for causing a train to move forward, instead of depending for the moving force upon the adhesion of one heavy vehicle alone,—namely, the locomotive." The present writer then pointed out that this fertile suggestion might be carried out by the employment of electric motors on the wheels or axles of each carriage. He further pointed out that such a system would result in a saving wear and tear of the permanent way, a diminution of shocks and injuries to passengers and goods, and a facility in going around curves. Besides this, the wheels would not slip when going up steep inclines, and, in starting from a station, speed could be attained in a small fraction of the time now required. As a sec-

ondary advantage, the construction of the permanent way would be very much less costly. This is undoubtedly the way in which an electric railway should be worked. It was supported by able engineers, and many of us can remember the admirable writings of Mr. Sprague upon the subject, in which he made it abundantly clear that such a system of traction would be beneficial in every way.

Although the method of working just described is ideal, it can be applied only to a trunk line about to be constructed in total independence of existing steam railroads. If anything is to be done on a large scale with trunk railroads, it must be by means of locomotives, and the advantages of an electrical system using locomotives are not nearly so great as in those cases in which electricity is applied to every axle of the train. It is owing to the great importance of these considerations that so much money has been spent on, and attention devoted to, the Heillmann locomotive, in which steam is generated on the train for the purpose of creating an electric current to be supplied to motors driving all the wheels of the train. Without saying that this complicated system has proved a success, still there is no doubt that those who have invested capital in the experiment have been satisfied that there is enough advantage in this method of propulsion to justify the carrying-on of extensive experiments. The whole of the advantage lies in the fact that power is delivered to every wheel of the train, no advantage being gained from the cheaper use of fuel at a stationary engine.

The examples given, while they indisputably show that electric traction under certain conditions is well able to compete with steam, are not sufficient to overcome the natural conservatism which holds to existing methods.

Hitherto reference has been made chiefly to the great trunk lines, but special attention must be given to the conditions of suburban traffic. Most of us remember, not so very many years ago, the surprise with which we learned that several short steam railways were having to give way to the electric tramways which had been started. In later years it is the great steam railway companies which have been noticing with alarm that their receipts are being largely diminished by the competition with electric tramways for suburban traffic. That this competition is so successful is due to several causes. One is that the natural roads and streets have been employed for the purpose, so that little or no purchase of land has been necessary. But perhaps the most important cause is the rapid succession of independent cars which becomes possible under this system, affording a great convenience to the traveling public and enabling them in many cases to start from their places of business in town and be landed at the doors of

their houses in the suburbs. These are very serious matters from the point of view of the railroad companies, because many of the companies are really dependent for their profits upon suburban traffic, and, if this source of revenue is to be taken away, it will seriously endanger the financial position of the railroads as a whole. These matters have become more evident in the United States than in any other country.

At the first glance it seems almost impossible for a railroad with fixed railway stations to be able to compete in convenience with an electric tramway passing along the ordinary thoroughfares, picking up and letting down passengers at all parts of the journey. Most persons, however, who know the conditions of traffic in the neighborhood of large towns in the United States, will probably agree that this matter of convenience does not apply to every householder, and that householders' wants, so far as this point is concerned, would be fully met if the stopping-places on the trunk line were in direct communication with the local street railways of the place.

A great deal has been written upon the comparative cost of working the suburban traffic upon trunk lines by steam and electricity. The question of a slight difference in cost one way or the other is of far less importance in the matter than the question whether it is possible for the suburban lines to run independent trains at a shorter headway,—a system practically impossible with steam locomotives, but advantageously workable from a central electric power station. If the public felt certain of being able to find a car or train ready to take them along the well-laid trunk railroads to their destination, so that they would never have to wait more than a few minutes at the station, there is no doubt that a great preference would be shown for travelling along these well-equipped lines. This appears to be the only solution that affords the railroad companies a hope of escape from the competition which they now have to face.

It must not be forgotten that there are some cases where electric traction is perfectly certain to take the place of steam, but, as a rule, these are special cases. Such supersedure will never be possible with trunk lines, except where water power is easily available. For a railway through a desert there cannot be the slightest doubt that electric locomotives would facilitate, not only the construction, but the working of the lines. During a recent visit to, and inspection of, the military railways on the Upper Nile the present writer was impressed with the enormous difficulties of carrying the railway from Wady-Halfa across the desert, where no water could be obtained for a distance of 230 miles, to Abu Ahmed. The difficulty consisted in the fact that, after the first one hundred and fifty miles had been laid, for every

train carrying rails and sleepers there had to be three or four trains carrying coal and water to supply the locomotives. He took occasion to impress this fact upon the authorities, and to show that, if the construction were to be entirely carried out as proposed, from the Wady-Halfa end of the line, it would be almost essential to work by means of electric locomotives. While these pages are being written, the sirdar has succeeded in capturing Abu Hamed, and doubtless the most important result of this success is that it enables him immediately, during the flood-season, to carry rails and sleepers to Abu Hamed, and to carry on the construction of the line from both ends, so diminishing the difficulty which threatened.

Another case in which electricity is bound to supplant steam is that of underground railroads, especially in London; and the great increase in the number of electric railroads in London is the surest evidence that before long the whole of the underground system will change from steam to electricity. This change would have been accomplished long ago, were it not for the expense of the transition stage, and certain difficulties which attached to the necessary change from steam to electricity on trains coming from the country into the underground system of London. These difficulties have been much exaggerated, and there is really nothing to prevent the immediate introduction of electricity in the underground system of London.

The conclusions derived from study extending over many years are as follows:

(1) In cases where water power is always available within a few hundred miles of a trunk line of railway, it is probable that economy would be served by introducing electric traction.

(2) In the case of an independent system of railway to be constructed in a new country utterly unaffected by the traffic from steam railroads, power can be applied to every axle of the train; wherefore it will be economical in such a case, in construction and in operation, to use electric propulsion in preference to steam.

(3) For desert railways, where water cannot be obtained, electric traction is eminently suitable.

(4) In underground railways, such as the Baltimore Tunnel and the London underground system, where economy is not so important as convenience and comfort, electricity must be employed; and, where such railways are to be constructed, economy makes electricity advisable.

(5) In cases of suburban traffic electricity would help to overcome the competition with street railways by supplying the public with separate and independent cars running at very frequent intervals on a well-maintained track.

MODERN WHARF IMPROVEMENTS AND PORT FACILITIES.

By Foster Crowell.

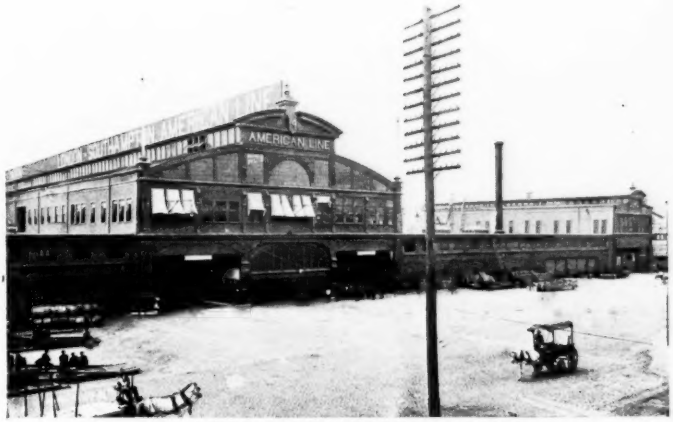
I. PRIVATE ENTERPRISE AND POLITICAL BLIGHT IN TYPICAL ATLANTIC CITIES.

THE steamship New York of the American line on her fifty-sixth voyage reached her New York berth, at Pier 14, North river, at 8.35 A. M., November 17, and sailed again at 10 A. M. November 18. The total time in port was twenty-five hours and twenty-five minutes, and there were only twenty-one and one-half working hours. But in that brief period there were discharged and loaded 3,467 tons of miscellaneous cargo, at the rate of 165 tons per hour, and about 2,400 tons of coal were put on board, at the rate of 112 tons per hour. In addition to this, 904 sacks of mail and the luggage of 613 passengers were handled,—that is, about 450 tons of mail and baggage. In round numbers the total stands as follows:

Cargo,	3,467	tons.
Coal,	2,400	"
Mail, etc.,	450	"
Total,	6,317	"

an average of 300 tons per working hour. This performance was undoubtedly a record-breaker in the field of handling miscellaneous cargo, and the officials of the International Navigation Company, from the highest to the lowest, still love to dwell on the "New York's quick turn," but there is no reason whatever to doubt that it could be repeated, or even excelled, at any time at Pier 14, although it is questionable whether there is at the present time any wharf equipment elsewhere capable of approaching it. While this was going on, the Red Star steamship "Friesland," of the same company, was loading on the other side of the same pier, and there were about 1,000 tons of her cargo on the wharf, besides 1,550 tons of "east-bound" for the New York. The capacity of the pier is far greater than that, however; at one time fully 8,000 tons of cargo were upon it, and the superintendent estimates that he "could put 12,000 tons measurement of cargo on Pier 14 and leave a driveway for trucks to come in and go out."

To go back to the handling operation, let us see first what this 6,317 tons really means, and what appliances and how many men are



THE NEW YORK PIERS OF THE AMERICAN LINE.
From a photograph furnished by Mr. Edward F. Wright, Dock Superintendent.

required. We will leave out of consideration the details of organization; for it may be taken for granted that they are of a very high order indeed, as the accomplishment in fact demonstrates. To bring to the wharf 6,317 tons of freight would require about 420 freight-cars (of the average size in use on American railways, or about twice that number of goods-wagons of the ordinary European type), if it could be brought in that way, which is not at present possible; if it came by trucks and drays, as some of it does, though by no means all, nearly 5,000 would be required. Before further discussing this subject of the handling of cargoes at the wharf, a digression may be pardoned, to condemn the habit of miscalling a wharf a "dock." New York rather plumes herself on being cosmopolitan, and is fond of characterizing neighboring cities as "provincial"; but at bottom she is as much so as any of them, and never more so than when she sets foot "on a dock" or appoints a "dock board" to build piers and bulkheads and wharves and everything, almost, along-shore, excepting docks, of which, to her shame be it said, and certainly to her disadvantage, she so far does not possess a single one, not counting the Atlantic and the Erie basins, which are private enterprises in Brooklyn, a city heretofore untrammeled by public ownership of the water-front.

In the case before us the number of men employed in handling this vast tonnage was: on cargo, 206; on coal, 135. This means that the movement amounted to nearly one ton per hour per man, taken from the hold and placed on the pier, or loaded and stowed, as the case might be. The ship's winches did most of the work on cargo; the fixed wharf winches are used only for landing part of the cargo. The coaling is all done by the wharf winches and a floating hoister.

The ship has seven hatches for cargo, and at each are several booms working to the same winch, with separate falls so arranged that the cargo can be brought to the deck by one lift and placed on wharf or in hold by another; or they can work in the same way to or from lighters on the outside of the ship. The wharf winches on Pier 14 are placed on the lower, or main, floor; but on Pier 15 they are on the second floor, these being the only two-storied piers in New York used for ocean passenger business. The second story is the best place for them, as it gives the operator a complete view of his work under all circumstances. On Pier 14 there are four Williamson double winches, each with two separate barrels, so that eight distinct operations can be going on simultaneously without interference; the lifts lead either to stepped derricks resting on the projecting main floor, outside the wharf-house, or "shed" in the vernacular, and hinged so that they can be folded back to clear the ship's side when not in use, or else to pulley-blocks running horizontally on a heavy wire rope which extends parallel to the wharf, just outside the shed, being rove through permanent and fixed vertical pole-derricks. The latter arrangement permits of the pulley-blocks being placed between the fixed derricks anywhere along the ship's side, the supporting wire rope (2½ inches in diameter) being capable of sustaining a load of five tons in any one bay.

The floating hoister consists of a covered scow, on which are winches with four barrels, working in connection with stepped derricks rigged temporarily on the ship; or the winches may be used to operate derricks on lighters. In coaling ship the shore winches and four stepped-derricks on the wharf side, and the floating hoister and four stepped-derricks on the ship, can be operated simultaneously, with a united effect of 140 tons of coal per hour, the coal being brought in barges, which lie, of course, along both sides of the ship. Much out-bound cargo does not come upon the wharf at all, but is hoisted on board directly from lighters by means of the floating hoister, by the ship's winches, in some cases, by their own power. Thus the full effective handling capacity can be exerted. Space does not permit a description of many interesting features of an ocean

SECOND STORY OF AMERICAN LINE PIER, NEW YORK.

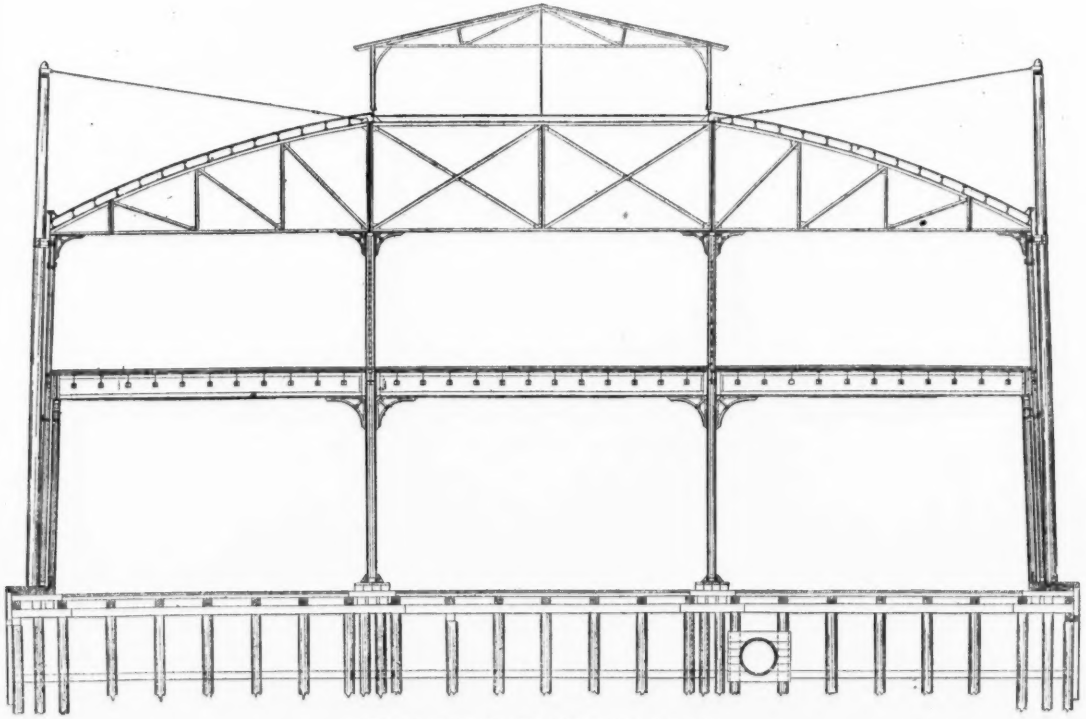
liner's cargo stowage and the special provisions and accommodations made therefor; for instance, on board the American liners there are large refrigerator holds for meats destined for the English markets; these meats are killed and dressed in the abattoir in New York harbor, and brought to the ship in refrigerator barges, from which they are loaded directly into the hold.

The floating hoister has its self-contained power, but the wharf winches are permanently piped for a supply of steam direct from the battery of boilers at the head of the wharf, which also provide the power for electric lighting, for fire-protection pressure service, etc. A description of the plant, very perfect of its kind, is not essential to the purpose of this article.

The facilities for embarking and disembarking passengers at the American line piers are far in advance of the ordinary practice, both by reason of the upper floor, which is used for that purpose, and which extends over the entire pier, and by the generous and intelligent provisions (utterly unknown elsewhere) for the minor comforts of passengers and their friends who come to welcome or to speed.

The comfort and facility of the second-floor arrangement strike one favorably in going "to see friends off," or in waiting for the ship to come up after she has been reported; but its chief value is en-

STEAMSHIP ST. LOUIS OF THE AMERICAN LINE COALING AT PIER 14, NEW YORK.



CROSS SECTION OF THE AMERICAN LINE PIER.

From the Company's Plans, through the courtesy of Mr. Clement Acton Griscom, Jr., Manager International Navigation Co.

joyed by the incoming passenger, for the horrors of the customs inspection are materially mitigated by it, and one can get through that barbarous business with much less annoyance and loss of time, owing to ample space unobstructed by anything else at the time, and to the system adopted of segregating the passengers according to the letters of their names and arranging the baggage for inspection correspondingly in separate spaces plainly marked with large letter signs. The second-class baggage is also kept separate, so that the least possible time is consumed, and at the worst the passengers are in physical comfort, relieved of confusion and trouble. When each one's luggage is "passed," it can be sent down a chute to the lower floor, at the head of the wharf, where carriage or express-wagon can drive in to get it. I have selected the wharf just described, because it is a specimen of the most advanced type; it is by no means typical, as has been stated, of the general condition on either side of the ocean, and it can truthfully be said that, compared with it, most of the present wharf outfits in use are primitive in the extreme. While it is gratifying to Americans to note that the most advanced and best plant is that of the only transatlantic American line, it can scarcely be satisfactory to national pride to reflect that in provision for commerce generally, throughout the seaports, the United States are behind the rest of the world.

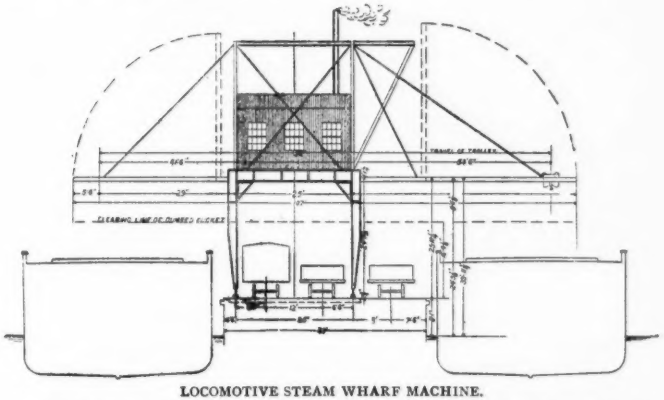
This condition is undeniable, and is due doubtless to the fact that the United States have no merchant marine of their own, speaking of course relatively. To state why they have no merchant marine would be a repetition of the story of "the house that Jack built."

> This is the platform, tattered and torn,
> Made by a party all forsworn,
> That milked the national cow too long,
> That tossed the tariff,
> That worried trade,
> That caught the panic,
> That ate the profit,
> That lay in business before that.

But this is not intended to convey the idea that there are not, in the United States, appliances suitable for wharf developments on the very highest scale; as a matter of fact, there are; it is only the opportunity for applying them to foreign commerce that is lacking. In the lake ports, and in private enterprises at many other points, there are in service plants as far in advance of the rest of the world as the ocean port facilities of the United States are behind it; and in the shipment of grain, of course, the great American elevators, though now somewhat antiquated, have for many years been famous.

This article deals with present conditions, which were well epito-

mized recently by a prominent railroad official in charge of the New York piers and the marine business of one of America's several "greatest railroads," when he remarked that in the last thirty years there has been no change in wharf methods and appliances; he was speaking, of course, of New York particularly. He was at the time, however, exerting himself to have new methods and plant devised and adopted which would revolutionize the business of freight-handling and vastly reduce the cost, and, since then, the changes he proposed have in part been decided on, and the illustration on this page shows one of the plants about to be erected.



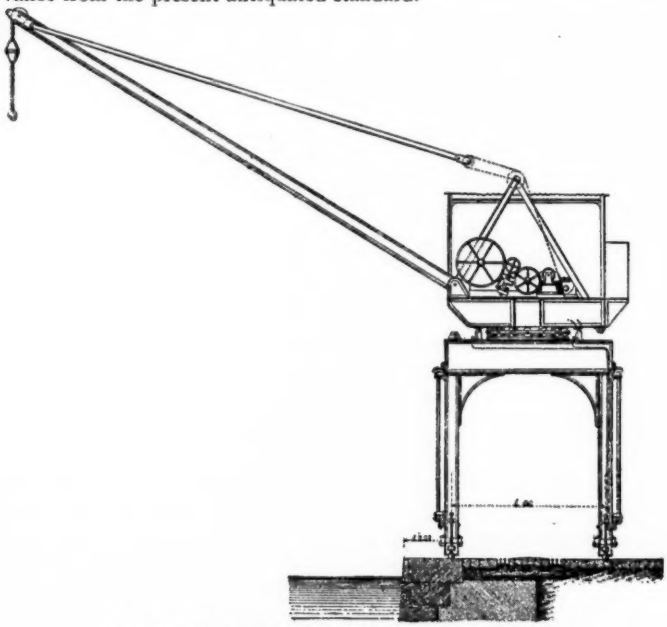
LOCOMOTIVE STEAM WHARF MACHINE.

Designed and built by the Brown Hoisting and Conveying Machine Co. for the Pennsylvania R. R., Pier J, Jersey City.

This machine is of 5 tons' lifting capacity, and is equipped with automatic buckets for handling bulk material; these buckets can be detached and the hook used for handling boxes, bales, or any other articles. By an arrangement of hoppers in connection with the pier leg at the left of the machine, bulk material can be loaded into box cars; this is an important part of the specifications for the machine, as on this pier a great deal of pyrites, sulphur, etc., is transferred from ships into box cars. To the right of the machine there is one track outside the pier leg. This arrangement was made so that long material, such as steel rails, lumber, etc., can be loaded and unloaded without having to pass any obstruction. The entire machine is driven by a steam engine and boiler in the house on top, and, besides hoisting its full load 150 feet per minute, will travel with full load along the pier at a speed of 600 feet per minute. The projections over the vessels are hinged, so that they can be thrown into a vertical position

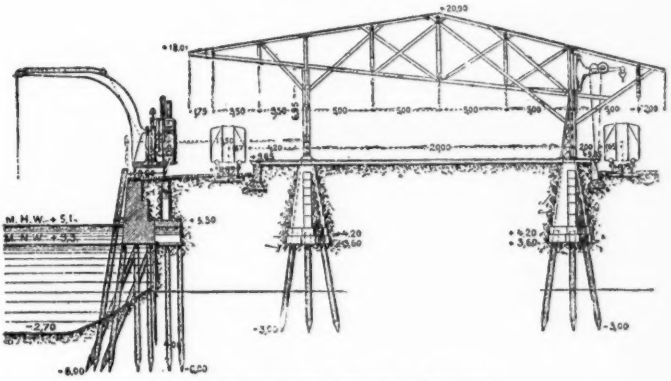
when not in use, leaving the edge of the wharf clear. These projections, or aprons, are raised by power. This machine is the first of its type, and it is expected to revolutionize the handling of material in New York harbor. It has been designed and manufactured, though not yet erected, by the Brown Hoisting and Conveying Machine Company, of Cleveland.

Other signs of a new era in wharf-plant development in the United States are not wanting, and the new wharves now being, or about to be, built at the port of New York will probably show a distinct advance from the present antiquated standard.



ELECTRIC CRANE PROPOSED FOR THE PORT OF DUNKIRK.

It may be said generally that what is true of New York in this regard applies in the main to the other American seaports; here and there, already, there are notable departures from the old usages and methods. For example, compressed-air locomotives and electricity have been tried on New Orleans wharves to expedite the shipping of cotton, and other sporadic cases of improvement might be mentioned; nevertheless, the fact remains, baldly stated, that old and costly methods of handling miscellaneous cargoes from wharf to ship

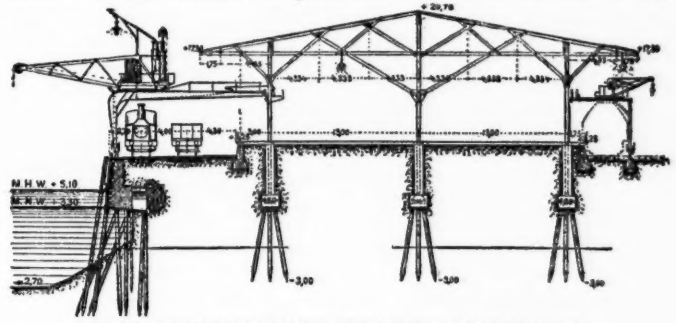


SHED ON THE VERSMANN QUAY, HAMBURG.

and from ship to wharf are everywhere in use, and the general New York conditions may be taken as typical.

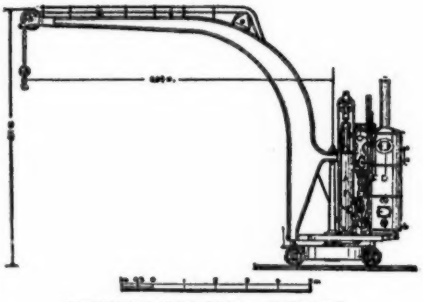
There are said to be now about 55 miles of wharf-room on the 20 miles of water-front that have been developed on Manhattan Island alone, afforded by 276 piers: of these the city of New York owns 151, of which only 51 are shedded, and 24 are owned in common, of which 10 are shedded.

A few of the private piers are provided with modern appliances, in the shape of coal-handling machinery and kindred plants; but nearly all, out of the entire lot, are destitute of everything except floor-space. This is a natural result of the prevailing system, whereby the city furnishes and builds the piers up to, and including, the floor, and leases them for a term of years to private parties; if the tenant desires sheds or other facilities, he provides them, as in the case of the



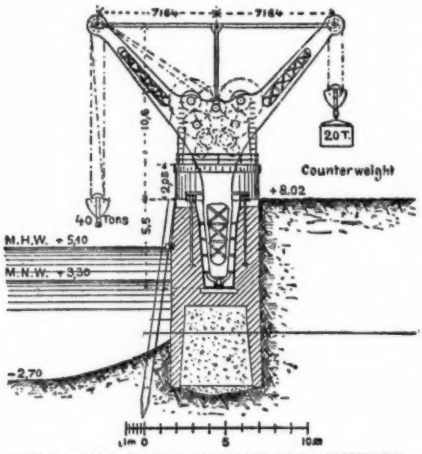
WHARF SHED WITH MOVABLE STEAM CRANE, HAMBURG QUAYS.

American line. There may be exceptions to the rule, but usually the buildings on piers are erected by the tenant; naturally only long-term leases justify such investments, and only comparatively few tenants can afford to make them.



MOVABLE STEAM CRANE, HAMBURG.

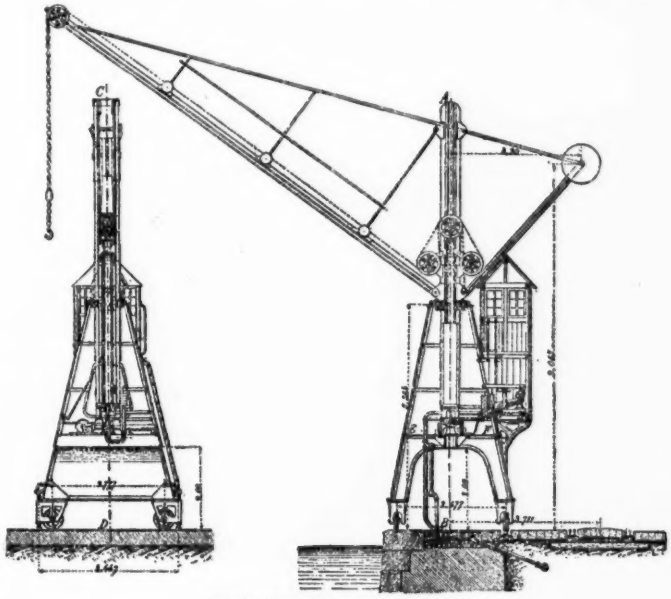
Apart from that, the competition from other parts of the harbor, especially on the Jersey shore, where there are direct rail-connections with the trunk-lines, places another barrier in the way of enterprise. It is to be hoped, rather than confidently expected, that New York will soon awake from her long slumber, and assert herself in this direction; there are a few signs astir. Recently the board of consulting engineers to the dock department reported in favor of a proposed marginal railroad along a portion of the water-front, to be built and controlled by the city. Up to the present time a few piers only are so situated that they have rail-connection. In the second article of this series more will be said on this point.



HAND CRANE ON THE DELMANN QUAY, HAMBURG.

In marked contrast with this picture of backwardness, let us take a few examples of European ports. In Glasgow the harbor is an entirely artificial one, whose leading features are later to be described. There they actually have docks. The docks and quays are controlled by the Clyde trustees. The trustees provide no warehouses, but have some thirty acres of sheds for the accommodation of goods in transit; they do not load or unload miscellaneous cargoes, this being

done by the ship-owners; but for coaling ships, hoisting heavy weights, etc., they have 42 steam and hydraulic cranes ranging in lifting power from 1½ tons to 75 tons, besides a 150-ton pillar crane capable of a lift of 100 feet from a depth of 20 feet below the quay to a height of 80 feet, with a working radius of 65 feet and a projection of 45 feet beyond its seat. In addition, there are 8¾ miles of harbor railway, connecting with the whole railway system of the United Kingdom. Berths are set apart for special tracks, and fully a half of the total quayage of 11,056 yards (6⅓ miles) is allocated to the leading lines of steamers trading to out-ports of Scotland, England, and Ireland; to the leading continental ports; to the British colonies, America, the East and West Indies, Africa, etc. The trustees

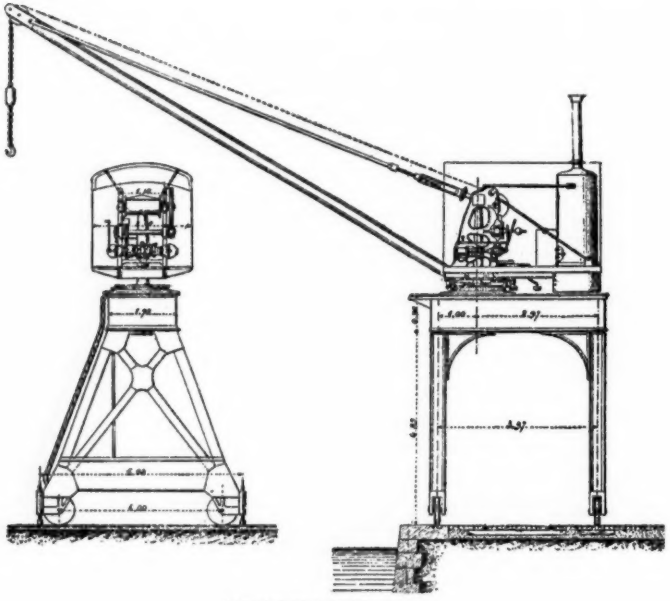


HYDRAULIC CRANE, MARSEILLES.

permit ship-owners having allocated berths to place steam cranes on the breasts of the quays, and, when the report from which these figures are taken was compiled, there were 32 of them in use, ranging up to 30 tons' lifting power.*

It would be interesting, if space permitted, to compare the yearly

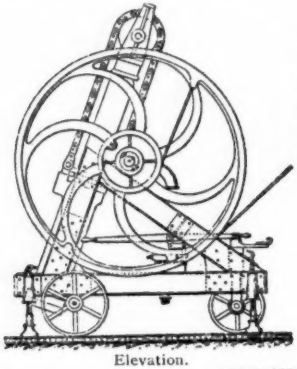
* Transactions Am. Soc. C. E., Vol. XXX.



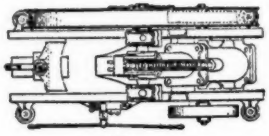
STEAM CRANE AT HAVRE.

results of operation, in tonnage and cost, of these six and one-third miles of highly-developed dock quays with those of the fifty-five miles of New York's "wharf-room."

In the port of Hamburg there were, a short time ago, about the same length of quays as at Glasgow; they were found sufficient to discharge and load 3,758 ships in one year. On the Hamburg quays there were then working 66 stationary steam and hydraulic cranes, ranging in capacity from 1 ton to 150

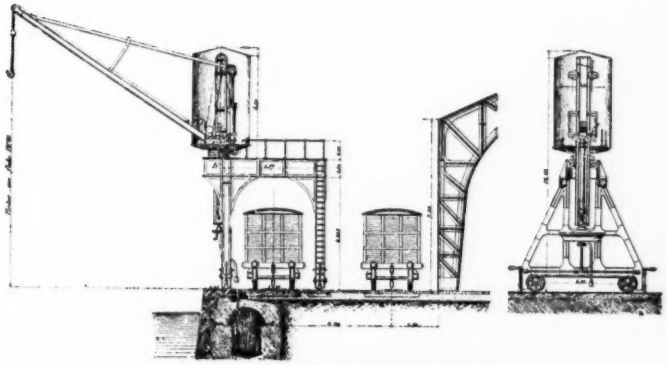


Elevation.

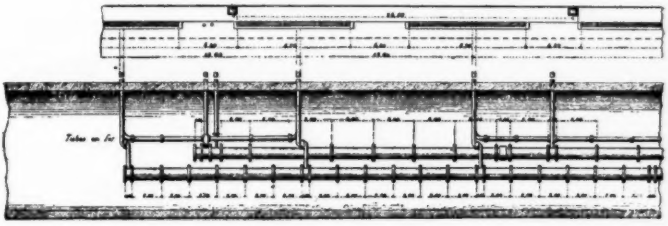


Plan.

HYDRAULIC HOIST, HAVRE.



HYDRAULIC TRAVELING CRANE AT HAVRE.

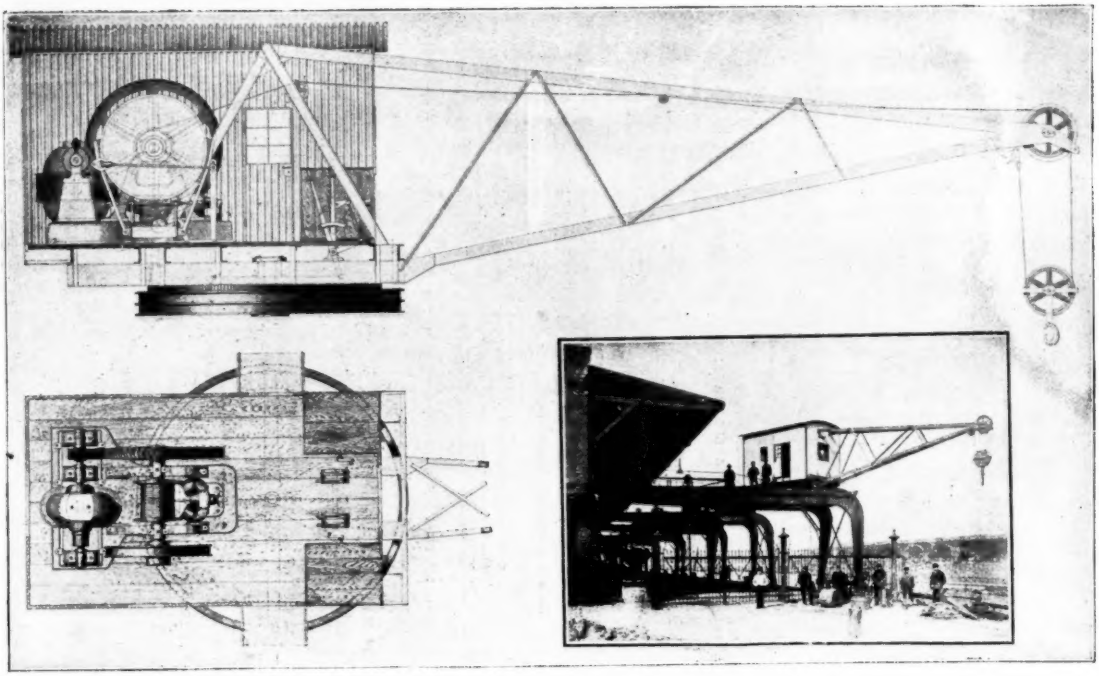


PLAN AND SECTION OF THE PIPE SYSTEM FOR HYDRAULIC TRAVELING CRANE SHOWN ABOVE.

tons, and 355 travelling cranes, mostly steam and electric. This makes a total of 421 cranes with a collective lifting power of about one thousand tons, which is more or less uniformly distributed along the quays, and gives an average lifting power of 60 pounds per foot of quay length.

Hamburg stands unrivalled in this respect, but throughout the ports of France we may find numerous fine examples, although the development has been slow, owing to peculiar conditions of administration. At Marseilles, Havre, Calais, and elsewhere the modern achievements have been very successful, especially in connection with the extensions of the railways to the quays, and with the very elaborate systems of sheds which prevail.

At Marseilles there are 9 locomotive cranes, capable of lifting more than 20 tons each, and a stationary, oscillating hydraulic shears of 120 tons, besides many floating derricks, of which the largest can



ELECTRIC CRANE ON THE PETERSEN QUAY, HAMBURG.

lift 60 tons. At Havre the number of large machines is more limited, but there are four notable ones, and many smaller hydraulic machines, owned and operated by a dock company.

The following table* gives the comparative situation, for the principal ports of France, of the development of the tracks, sheds, and machinery for loading and unloading in 1884 and 1893, and shows the activity which has been displayed during this period in the improvement of the plant at these ports.

Ports.		Length of tracks on quays. Meters.	Area of sheds. Square meters.	Machines for loading and unloading.					
				Hand or steam.			Less than 3 tons.		
				100 tons and over.	20 to 100 tons.	3 to 20 tons.	Stationary steam.	Floating.	Hydraulic.
Marseilles	1884..	18000	62800	....	7	4	2	6	39
	1893..	43000	82000	1	8	6	1	7	85
Havre	1884..	20000	54000	1	2	8	5	4	....
	1893..	37000	108000	1	3	9	12	9	44
Dunkirk	1884..	15000	.....	....	....	....	....	....	....
									Projected
	1893..	35000	20500	....	2	1	19	9	21
Rouen	1884..	8500	.....	....	1	2	13	22	...
	1893..	25500	12000	....	1	2	10	36	15
Bordeaux	1884..	14500	.....	...	....	....	....	....	....
	1893..	16500	4800	....	1	....	24	....	....
St. Nazaire	1884..	3000	8000	....	3	2	16	7	....
	1893..	18000	9300	....	2	5	15	10	....
Dieppe	1884..	6000	2400	....	....	....	....	....	....
	1893..	10000	5300	....	1	4	29	....	....
Calais	1884..	35000	.....	....	....	3	8	....	....
	1893..	21000	23000	....	1	5	8	....	16

As against all this, we have in the new world one conspicuous example, in the hydraulic oscillating shears of the Maryland Steel Company, at Sparrow's Point, Md., with a capacity of 125 tons and designed by Mr. Frank B. King. This machine is probably the very finest of its class in the world; it was used to land the great Krupp gun on its way to the Chicago Columbian exposition, and it was and is the only permanent apparatus on the American side of the water that could land that weight. Its lift is 65 feet, in the clear, and it has a lateral motion, at right-angles to the face, of from 9 feet 3 inches inboard to 49 feet 6 inches outboard, measured from the heels of the front legs. These dimensions adapt it for use in shipping ordnance, locomotives entire, marine boilers, and marine engines of considerable size. Such

* Transactions Am. Soc. C. E., Vol. XXX.

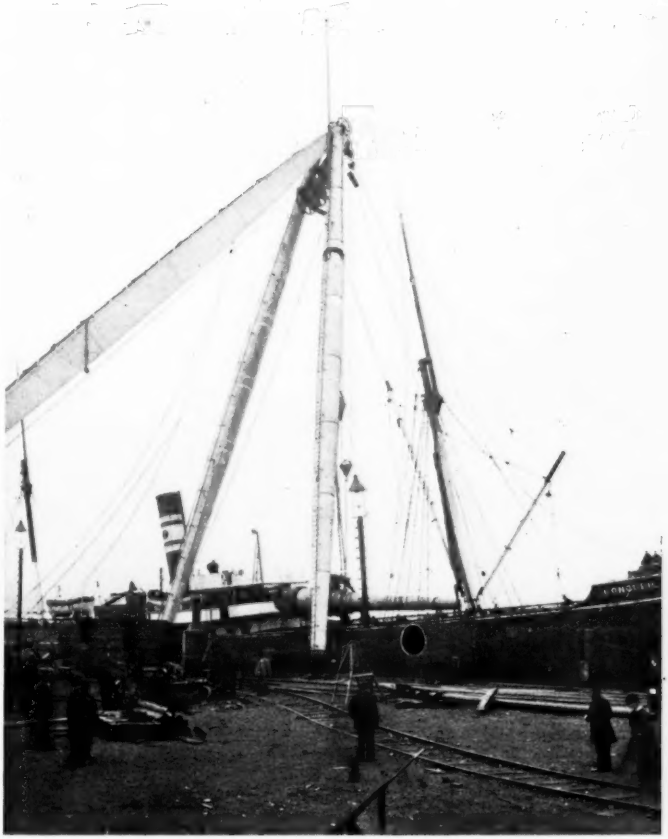
150 TON STEAM SWINGING CRANE IN THE SEGELSCHIFFHAFEN, HAMBURG HARBOR. THE HEAVIEST COMMERCIAL CRANE IN THE WORLD.

an apparatus is an essential in every well-furnished port, if there is to be development of the heavier kinds of manufacturing, and it would well pay any city to liberally provide such plant for its wharves.

It is only fair, when contrasting these fine examples of maritime commercial plant with the primitive, ungainly, and frightfully expensive methods on the American side of the water, to bear in mind the disadvantages which have existed, in New York city more particularly, and which have stood naturally in the way of development.

In the first place, we have the principal cause, already suggested, of the absence of American vessels in foreign trade; it is not to be expected, perhaps, that the same careful provision will be made for foreign vessels that would be made for our own, if we had them, even though the ultimate cost and loss fall upon us, and though the present system of giving up un-needed miles and miles of water-front is so inconvenient, ugly, and detrimental.

In the second place, we have the almost insurmountable obstacle of "politics," which in New York places the development and care of the wharf system in the hands of a dock board, as a reward for party services its members could not have rendered had they been endowed with the proper qualifications and trained for this very important task. This remark is general; it is not meant for an attack on the present members of the board (Republicans), or their predecessors (Democrats); it is aimed at the system, so prevalent in America and the Transvaal, but nowhere else, of putting public improvements in the hands of commissions and boards of "business men," instead of



THE 125 TON OSCILLATING HYDRAULIC SHEARS OF THE MARYLAND STEEL CO., BALTIMORE HARBOR, UNLOADING THE KRUPP GUN.

From a photograph in the collection of Mr. Stephen W. Baldwin.

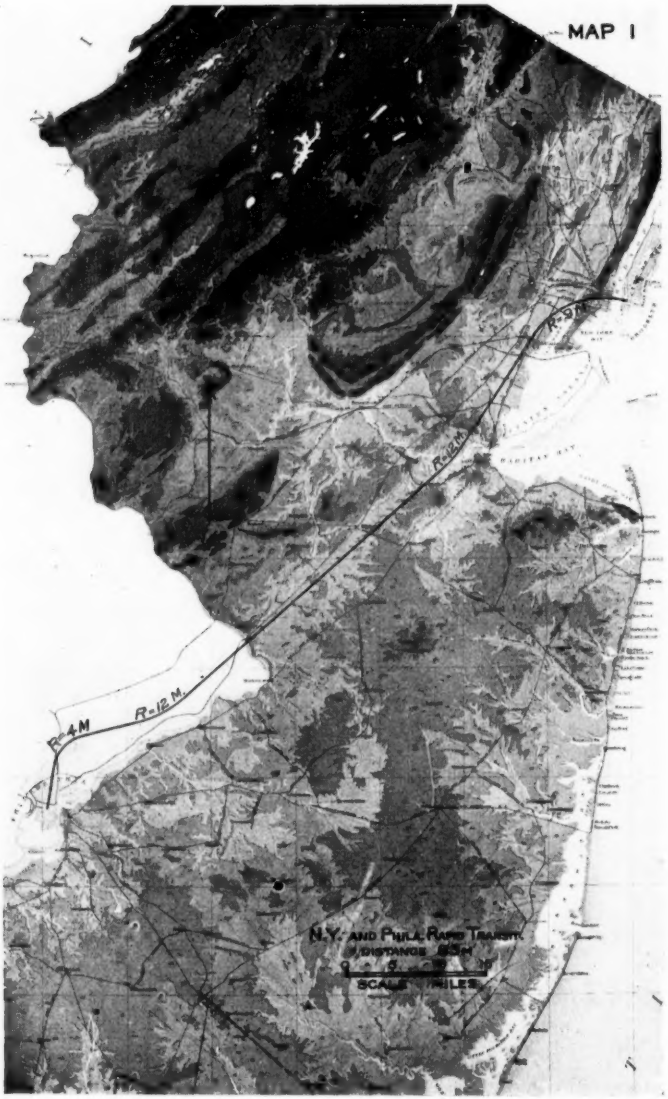
directly into the hands of those who possess the knowledge and skill to design and execute the works. What is always done in private enterprises is exceptional in public ones, and there, in a word, is the reason for American public imbecilities and mediocrities. Not long ago a very important bridge was to be built, and, as usual, the grocery stores and counting rooms were being searched for "suitable" men to appoint upon the commission. A friend of one of the appointing powers suggested that, out of the half dozen or so, two should belong

THE WATER FRONT OF ANTWERP.

to the profession of civil engineering. The reform mayor brought his fist down hard and forcibly, and said no! there should be no engineers on any commission, if he could help it. Until the country outgrows such ignorance as that remark laid bare, perfection in public works need not be looked for.

In the third place, it is extremely questionable whether, even under enlightened direction, it would be possible to produce as good results in providing dock facilities under the city's direct management as if the matter were left to private enterprise,—of course, under proper civic control as to certain points. In the case of the superstructures erected by the great steamship companies upon the city piers this seems to be admitted, even by the New York dock department. To go a step farther, and give free scope to intelligent and active competition in planning and utilizing the wharves, would doubtless revolutionize the business of commerce; and doubtless, too, in that case New York would soon have a very considerable mileage of superfluous wharves on her hands, unless the commerce of the port should increase commensurately with the increase of capacity of the individual wharves due to the higher development. There would then be room for other use of the magnificent water-front; it could be made beautiful and attractive and charming and healthful, as in the more civilized places of the world, instead of what it is.

The illustrations on pages 20 to 26 of this article were reproduced from the Transactions of the American Society of Civil Engineers.


MAP 1
R-9M
R-4M
R-12M
N.Y. AND PHILA. RAPID TRANSIT
DISTANCE 85M
SCALE MILES

THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL.

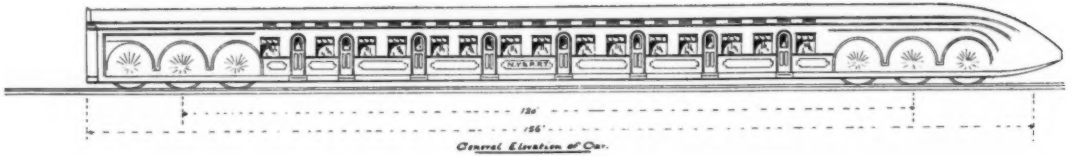
By Charles Henry Davis and F. Stuart Williamson.

I.

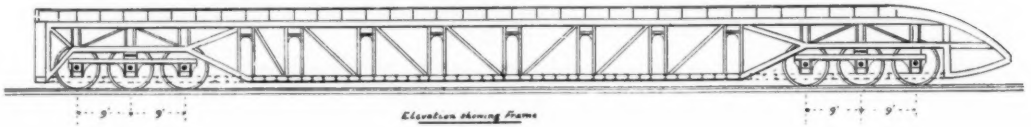
IN THE ENGINEERING MAGAZINE for May and June, 1897, appeared an article entitled "Electric Traction under Steam-Railway Conditions." One of the conclusions reached was that electric motors could be used more profitably than steam "where higher speeds are required than can be attained by steam locomotives"; it is the purpose of this and the succeeding paper to show, by discussing a specific case, the possibility of producing, by the use of electric motors, a speed supposed to be thought of only by visionary people. The present paper will discuss the engineering problems involved and the possibilities of their solution; the second will show the approximate cost, and the possibilities of a return warranting the investment.

The special case chosen is the bringing of Philadelphia within thirty-six minutes of New York harbor. The proposed road would connect a population of 1,500,000 with another of 4,000,000. The length of the line, as shown on Map No. 1, would be about 85 miles, so that an average speed of 141⅔ miles per hour (2.36 miles per minute) would be required in order to accomplish the distance in 36 minutes. Allowing six minutes and 8.49 miles (44,827 feet) at either terminus within which to get up and reduce speed, the rest, 68.02 miles (359,146 feet), would have to be made in 24 minutes, or at the rate of 170.05 miles per hour (14,964.4 feet per minute = 249.4 feet per second). The proposed car, shown on Plates No. 1 and 2, would weigh about 150 tons when loaded to capacity. On a grade of one-fifth of one per cent. such a car would offer a resistance, due to the grade, of 4 pounds per ton, or a total of 600 pounds per car, equal to 272 h. p. at 170 miles per hour; our ruling grade has been taken at ⅛ of 1 per cent. (except in one case, shown on Map No. 2, where the distance is so short that the excess can be neglected). Map No. 2 gives a profile of the proposed line; Map No. 3 (in sections) shows the proposed line on a scale giving a rough idea of the details of topography, railroad and road-crossings, rivers and streams. These maps have been made from United States government and State surveys, and are only approximate.

To accomplish its purpose the proposed road must take the minimum time, and make it with precision and safety and with great fre-

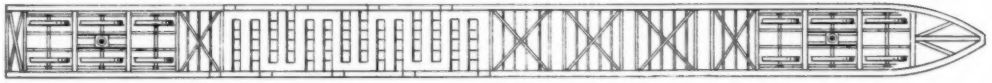


General Elevation of Car.



Elevation showing Frame

PLATE. No 1.



Half Plan showing Seats

Half Plan showing Frame

quency, for passengers must not be kept waiting at terminals; it will be admitted that, should Philadelphia be connected with New York by a time not exceeding that taken on the Brooklyn bridge, connecting New York with Brooklyn, and with a minute headway, there would be little doubt of the success of the road performing the service. Therefore high speed, frequency, and safety, providing the road can offer low fares, are the objects to attain, irrespective (at the moment) of constructive cost.

In discussing the engineering problems let us divide our subject under the following headings:

FIRST COST:

RIGHT OF WAY AND REAL ESTATE.

CONSTRUCTION.

1. Engineering and surveying. 2. Clearing. 3. Grading, ditching, etc. 4. Tunnels. 5. Masonry, culverts, bridges, trestles. 6. Fencing, cattle guards, road-crossings. 7. Ballasting. 8. Ties. 9. Rails. 10. Track-laying, lining, and surfacing.

(electric) 11. Rail bonding.

(electric) 12. Overhead trolley line, or third rail.

13. Signals. 14. Telegraph. 15. Stations and all buildings (including buildings for central power stations of electric roads). 16. Terminals.

EQUIPMENT.

(steam) 1. Locomotives and tenders.

(electric) 2. Motor cars or electric locomotives. 3. Passenger cars. 4. Freight cars.

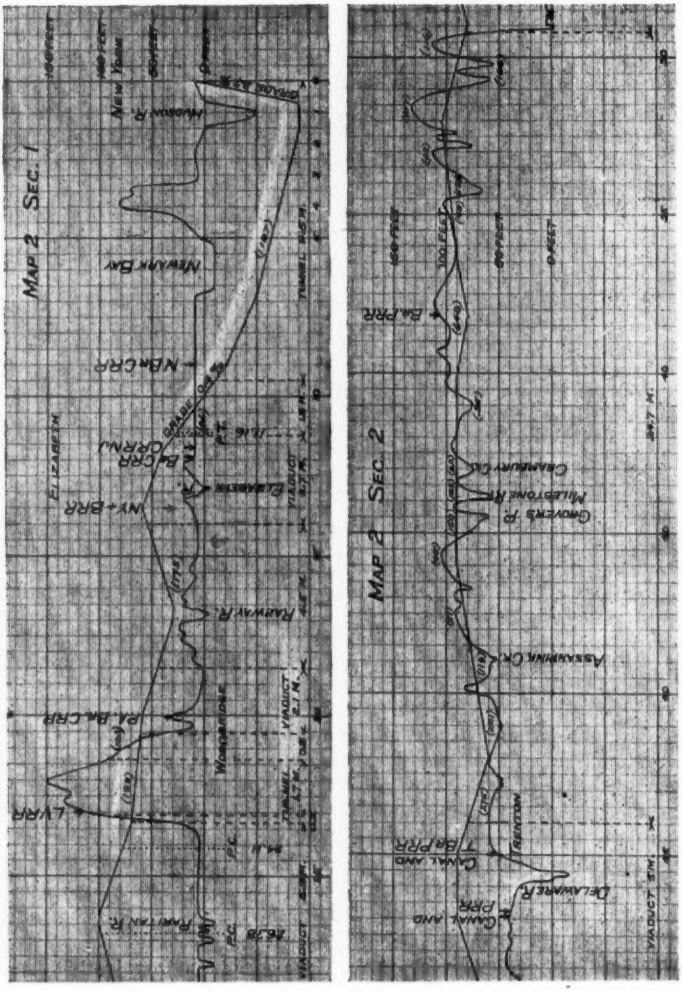
(electric) 5. Electric feeder lines and ground return circuit.

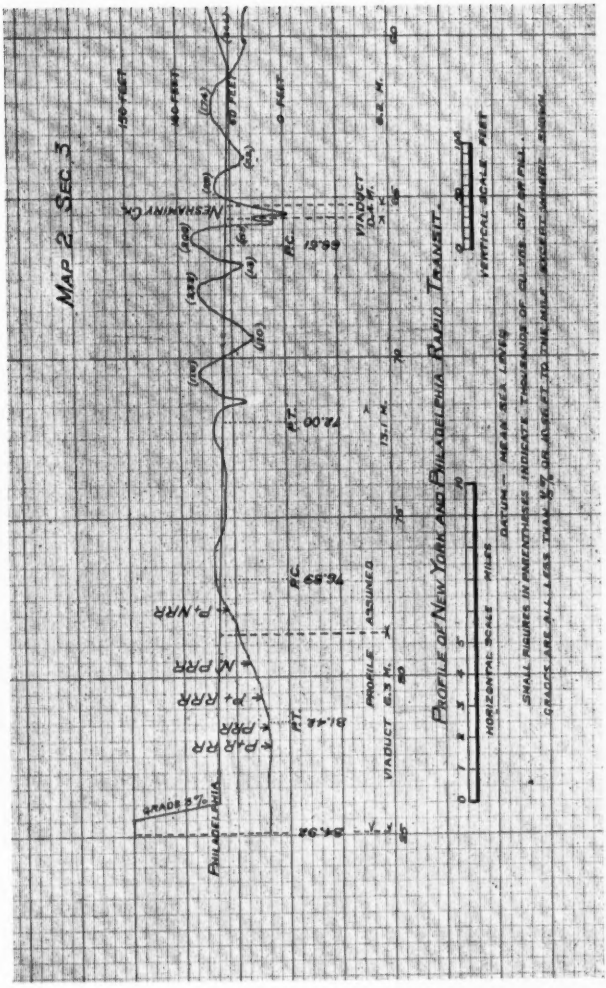
(electric) 6. Central power stations (not including buildings which are considered under "Construction").

GENERAL.

1. Discount on bonds. 2. Interest on bonds to opening of road. 3. Taxes to opening of road. 4. Office expenses, salaries, etc., to opening of road. 5. Contingent and miscellaneous not itemized, to opening of road.

Right of way and Real estate relate only to cost; under "Construction," items No. 1, 2, 3, 4, 6, 11, 14, and 15 will not affect the solution of the problem, as the cost is the only element involved; let us, then, examine in detail the other items under this division. Item No. 5, so far as masonry and culverts are concerned, depends upon the cost alone. Bridges and trestles must be built to carry uniform moving loads of one ton per foot of single track. The load is concentrated, 75 tons resting on each 18-foot wheel-base, and the shortest distance, center to center, between any two wheel-bases is 30 feet. These loads do not exceed those now carried, but the proposed speed is much higher. It is apparent, however, that by reducing (if this were necessary) the span between piers or bents we can provide against any vibratory action which might cause trouble on existing bridges at such

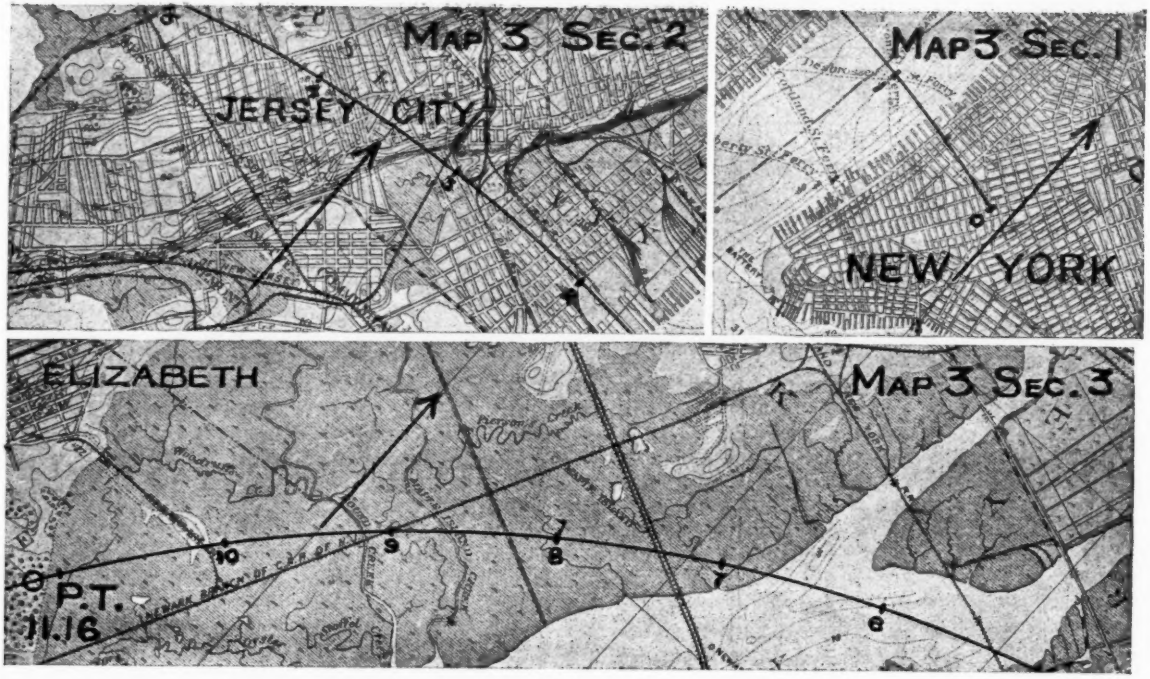

MAP 2 SEC. 1
NEWARK BAY
N.B.A.CRR
ELIZABETH
RAHWAY R.
PASSAIC R.
MAP 2 SEC. 2
B.A. PRR
MILESTONE R.
CHARLOTTE CR.
ASSANUNK CR.
TRENTON
DELAWARE R.
CANAL AND B&P RR
VIADUCT

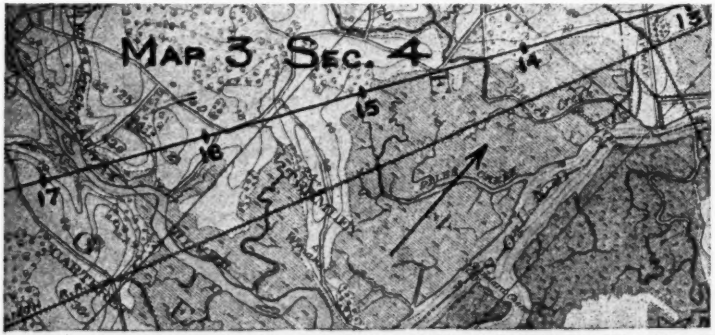

MAP 2 SEC. 3
PROFILE OF NEW YORK AND PHILADELPHIA RAPID TRANSIT
HORIZONTAL SCALE MILES
VERTICAL SCALE FEET
DATUM — MEAN SEA LEVEL
SMALL FIGURES IN PARENTHESES INDICATE THOUSANDS OF CU. YDS. CUT OR FILL.
GRADES ARE ALL LESS THAN 3% OR 158 FEET TO THE MILE EXCEPT WHERE SHOWN.
PHILADELPHIA
GRADE 3%
P. NRR
M. PRR
P. RRR
PRR
P.R.R. RR
NESHAMINY CK.
VIADUCT 6.3 M.
PROFILE ASSUMED
VIADUCT 0.4 M.
13.1 M.
B.C. 19.66
P.C. 76.89
P.T. 72.00
84.38
81.48
150 FEET
100 FEET
60 FEET
0 FEET

a speed. Of course there should be no grade-crossings. Items No. 7, 8, 9, and 10 can be discussed together. The lowest possible train resistance is a necessity in order to maintain the high speed required and to keep within a reasonable horse-power limit. A rigid road-bed is the only means of accomplishing this. A rail high in carbon and correspondingly hard, with a thin, broad head, nine to twelve inches deep, and patterned somewhat after the recommended standard of the American Society of Civil Engineers, but wider and thinner in the head, would, if properly supported, give a longer life than existing rails even with the proposed weights and speeds. The fiber stress of the steel would not be exceeded, and the high speed would be of advantage, as the hammer-blow of reciprocating parts would not exist with gearless electric motors. The stiffness of such a rail would be more than six times that of our highest and heaviest existing rails. The weight of this rail would be about 250 pounds per yard. Each rail being sixty feet long, the total weight would be 5,000 pounds. Gage might be standard or even broader. The importance of preventing the rails from spreading or breaking would probably require the use of braced steel chairs. Metal ties, laid two feet from center to center, carrying four rails, so as to give the maximum stability vertically and laterally, could be used; rail joints could be of girder and double angle plate pattern, giving even greater strength and stiffness than the rail itself; rails might be cut obliquely, to add to the ease of riding; ballasting should consist of heavy broken stone on edge as a sub-base; ties should be supported on concrete laid upon the layer of broken stone (after the practice of cable and underground electric roads) filled in and around, flush, with small, broken stone. Such a track would not be subject to the waves which are created before and after our existing trains, causing such destruction and excessive resistance. To reduce oscillation one rail could be slightly elevated the entire length of the line, probably reducing the train resistance as well as partly removing a motion disagreeable to the passengers. On the sharpest curve (4-mile radius, 16′-17′ angle of deflection) the elevation of the outer rail would not exceed 3.5 inches (really less than this, as the center of gravity of our car is about at the center line of axles, 3½ feet above top of rail); these curves would offer little additional resistance (one 4-mile radius, one of 9 miles, and two of 12 miles, respectively 16′-17′, 7′-8′, and 5′-6′ deflection angles, and .06 ft., .027 feet, and .023 feet middle ordinates) over that of tangents, for their large radius and high velocity would tend to reduce it. Assuming, however, that it will not be materially reduced, present practice shows a resistance of about ⅓ of a pound per ton per degree of curvature,

with track in good condition and trains at ordinary speeds, so that our 4-mile curve would have a resistance of 1·9 of a pound per ton, or a total of 16.6 pounds per car, equal to about 7.5 h. p. at 170 miles per hour, which is probably eliminated by the conditions stated above. Item No. 12 would of necessity be a "third rail." It could be placed close to the side of the car, elevated about two feet above the top of rails (three feet above top of ties) and supported on the ties as permanently and substantially as the other rails. Plate No. 2 shows a proposed method which would give the third rail perfect alignment and surface; this rail could be of steel and supplied with current from the feeder system, carried between the tracks as shown. The contact shoes could be carried from the trucks on a lever swinging from a center 3½ feet from the top of rails; springs would hold the shoes below the center and against the third rail, or, if the shoes were thrown up by an obstacle and the springs passed the coincident line of the lever, it would hold the shoes from the third rail until they were put down again by the motorman. This device could be patterned somewhat after the one in use on the Brooklyn Bridge. There seem to be no great difficulties in the use of such a third-rail system, or in collecting any amount of current requisite even at the high velocity of operation. The next item, No. 13, covering the signal system, is of the greatest importance, and in some respects the most difficult to solve; on such a road, operating trains at 170 miles an hour, or 249.4 feet a second, equal to 2.853 miles a minute (14,964.4 feet per minute), our system of signaling must be perfection itself; it must be automatic, not only in giving a danger-signal to the motorman, but in making it impossible for him to obtain power from the third rail when the signal is at danger, and, in addition, must put on his brakes, if he fail to do so himself; furthermore, it must be of such a nature that any fault in any link of the system will throw everything to danger.

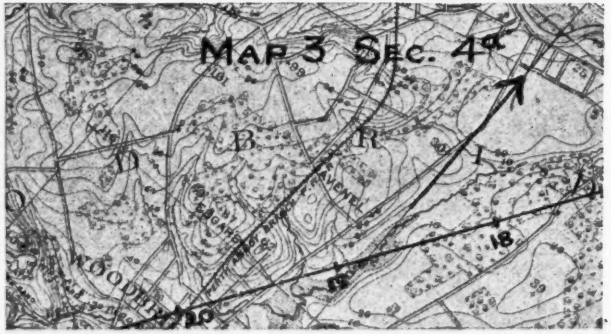
A suggestion of such a system is outlined in Plate No. 3. The heavy base line indicates the track; a-b, b-c, c-d, etc., are sections, each of a length not less than the distance which the fastest train would cover in the least allowable headway; while the smaller subsections, a-x, x-y, y-z, z-b, etc., are of such length that any train running at its maximum speed can stop within any sub-section without injury to the passengers. At "a," "b," "c," "d," etc., are signal towers, and at "x," "y," and "z" distance signals operated from the following tower. In the signal towers would be the power stations or sub-stations for distribution and control of the current to the third rail. The horizontal line of numerals indicates the first, second, third, and fourth position of trains as they enter and pass

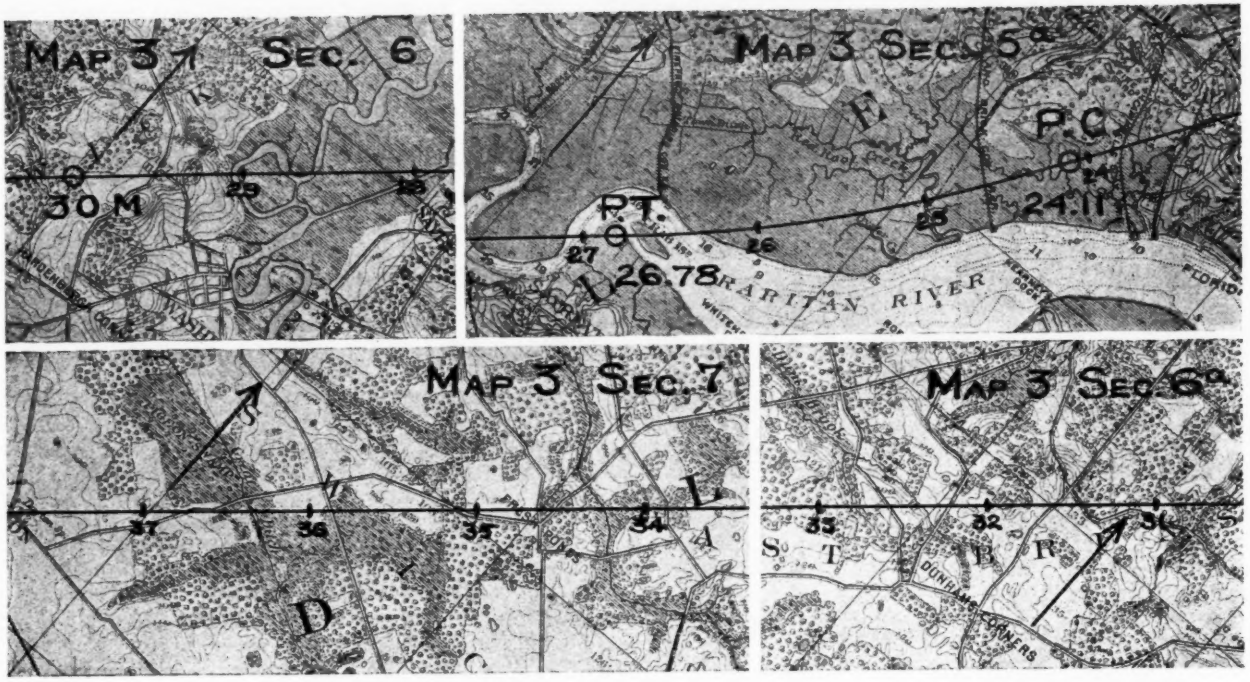

MAP 3 SEC. 2
JERSEY CITY
MAP 3 SEC. 1
NEW YORK
ELIZABETH
MAP 3 SEC. 3
P.T.
11.16

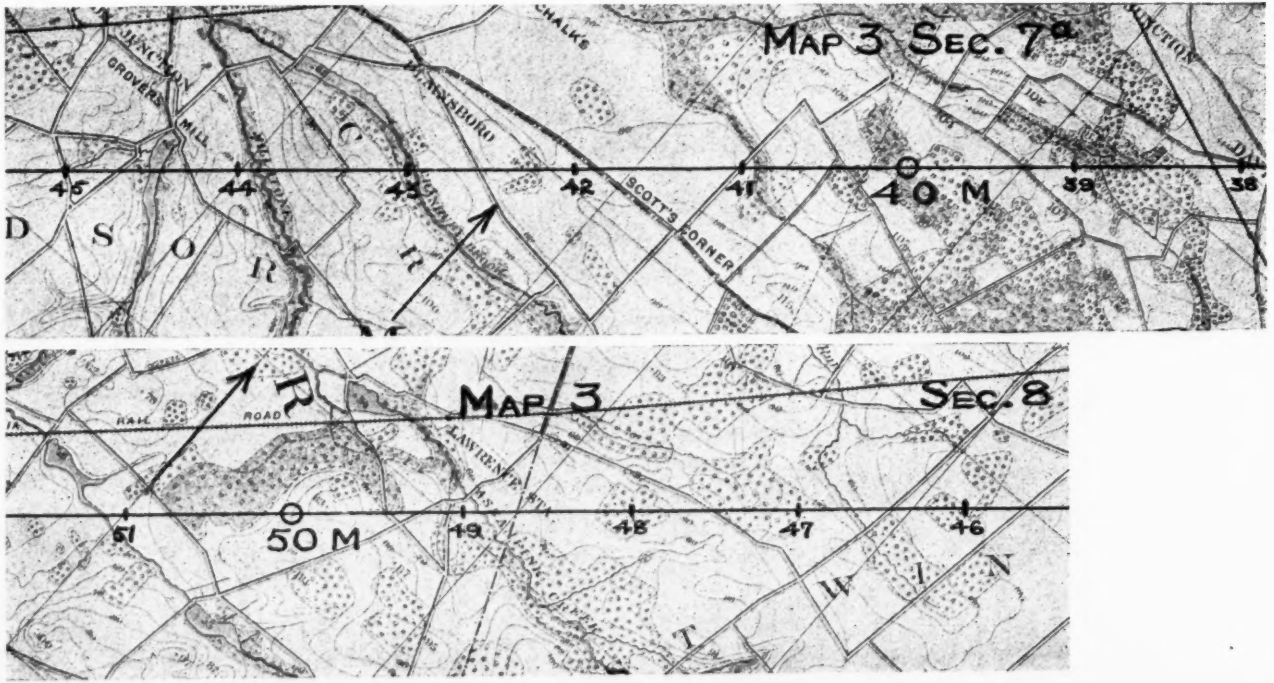

MAP 3 SEC. 4
13
14
15
16
17

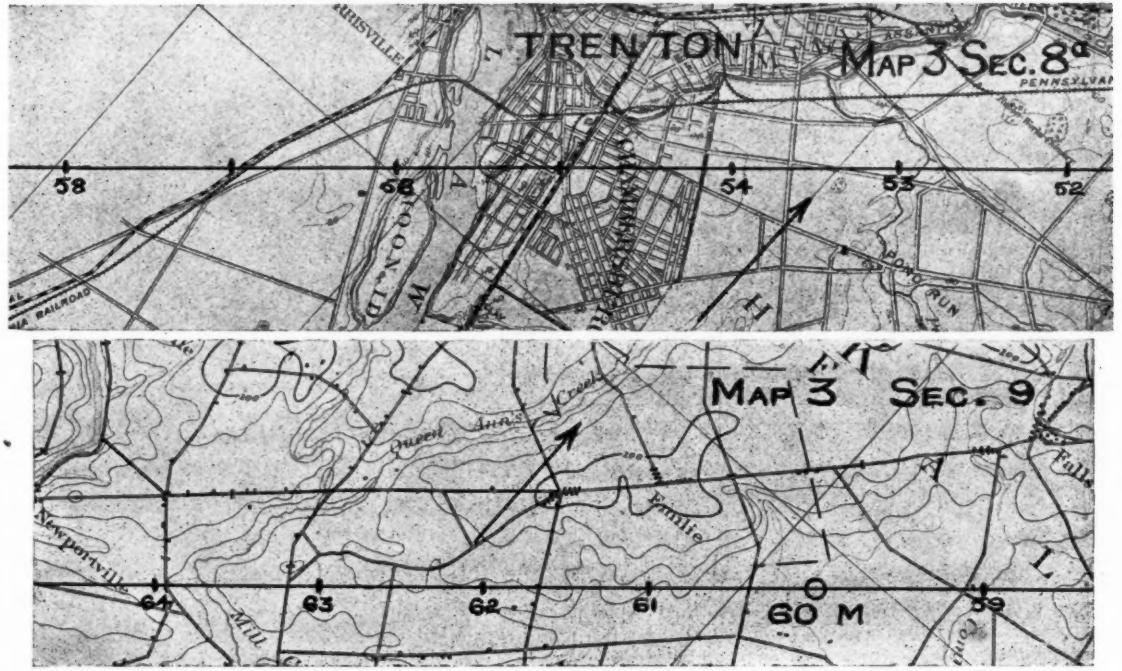
MAP 3 SEC. 3a

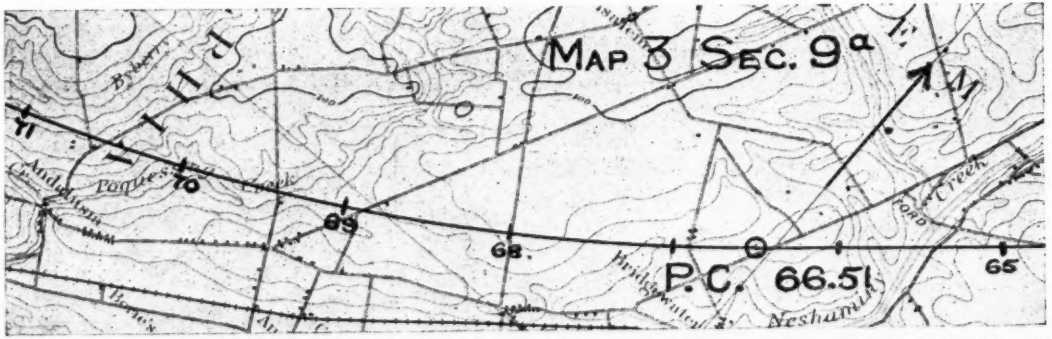
MAP 3
21
SEC. 5

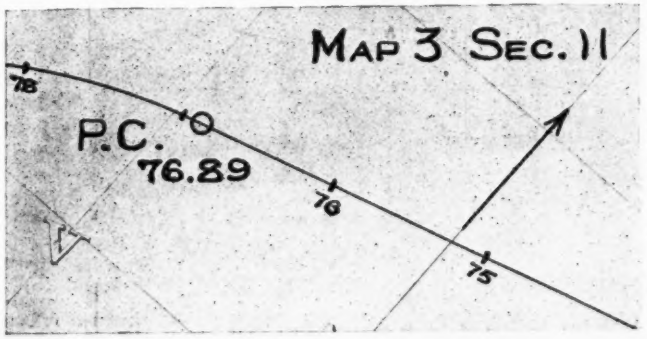

MAP 3 SEC. 4a
18
19

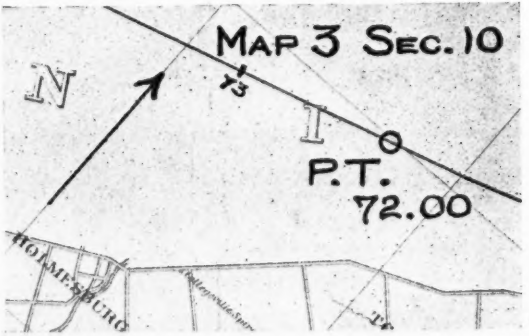

MAP 3 SEC. 6
30 M
25
MAP 3 SEC. 5a
F
P.C.
24.11
P.T.
26.78
RARITAN RIVER
MAP 3 SEC. 7
37
36
35
34
D
A
MAP 3 SEC. 6a
33
32
31
S
T
B
R
DUNHAM CORNERS

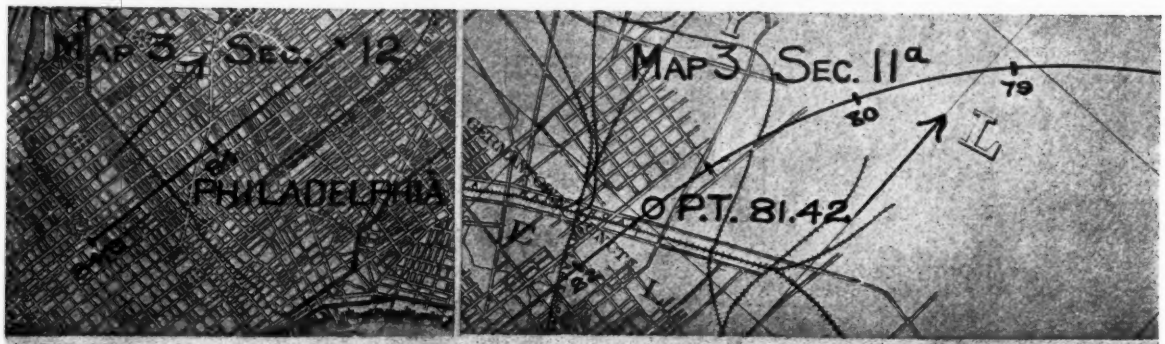

MAP 3 SEC. 7a
GROVERS MILL
SCOTT'S CORNER
45
44
43
42
41
40 M
39
38
D S O R
MAP 3
SEC. 8
RAILROAD
LAWRENCE
51
50 M
49
48
47
46
T


TRENTON
MAP 3 SEC. 8a
MAP 3 SEC. 9
58
56
54
53
52
64
63
62
61
60 M
59
Queen Anne's Creek
Pennie
Newportville
Mill
Falls
L.


MAP 3 SEC. 9a
N
71
70
69
68
P.C. 66.51
65
Neshanuck
Creek


MAP 3 SEC. 11
78
P.C.
76.89
76
75


MAP 3 SEC. 10
N
73
P.T.
72.00



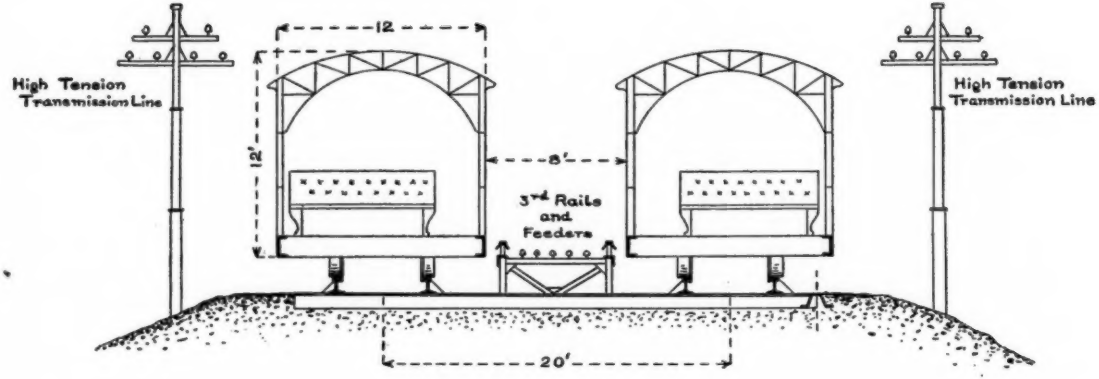
N.Y.+P.R.T.

DETAIL SECTION MAPS OF PROPOSED ROUTE

STATION POINTS, FROM N.Y. TO PHILA.,
ONE MILE APART ARE INDICATED IN SMALL FIGURES.
ARROWS SHOW NORTH AND SOUTH LINE.
CONTOURS 10 FT. APART. SCALE ONE MILE TO AN INCH.

through the blocks controlled by towers "a," "b," "c," and "d"; the letters "S" and "D" in the first five horizontal lines show whether the signal at that point is at "Safety" or at "Danger"; while the numerals "1s", "2s", "3s", and "4s" are opposite the successive lines corresponding to the successive positions of each train, 1, 2, 3, and 4; similarly the letters "L" and "D" in the second five horizontal lines show whether that section is "Live" or "Dead," with corresponding reference numbers "1p", "2p", "3p", and "4p." The towers are interlocked, so that "S" cannot be shown at "a-x" until "D" has been shown at "b," nor can "S" be shown at "a-y" until the two sections each side of "b" are made "dead." It will be noticed that the section upon which a train is running and the one immediately ahead always have current, while the two sections directly following a train are always dead; there are also three danger signals behind every train. The interlocking would be so arranged that signals behind a train could not be thrown to "S," until the train had passed out of the section, thus always maintaining signals and current connections as shown in the diagram. It will at once be seen that the capacity of a given track, in number of trains, depends upon four times the length in which a train can be stopped, without danger to the passengers. This distance might have to be a greater multiple, six or eight; our succeeding article will consider this question. The system of signals suggested does not involve mechanism or methods not already found reliable and satisfactory; they are, however, applied somewhat differently. In the plan proposed, if a signal should go to danger, it would show the ordinary semaphor or light (at night), and at the same time it could have a device, to be operated from the passing motorman's cab, to give him warning. Setting the signal to danger would also throw into place a rod close to the third rail, somewhat like the safety rods used with interlocking signals and switches of to-day. This rod would have a long gradual incline approach, and project above the third rail sufficiently to throw up the sliding shoes past their center, so that the springs would hold them clear of the third rail, thus cutting off the power. The motorman's ampere indicator would also warn him. By a similar device, on entering a dead section, should the engineer have failed to apply his brakes at the first signal, a lever could be thrown, opening a valve similar to the present "conductor's valve," thus applying them automatically. Some such automatic combination must be relied upon to make the road safe, with no possibility of rear end collisions. Under item No. 16, covering terminals, we have a very important problem to solve. The units will be heavy, will arrive at high speeds, and must get under way and up to speed quickly; they must

Plate 2



Cross Section.

PLATE 3

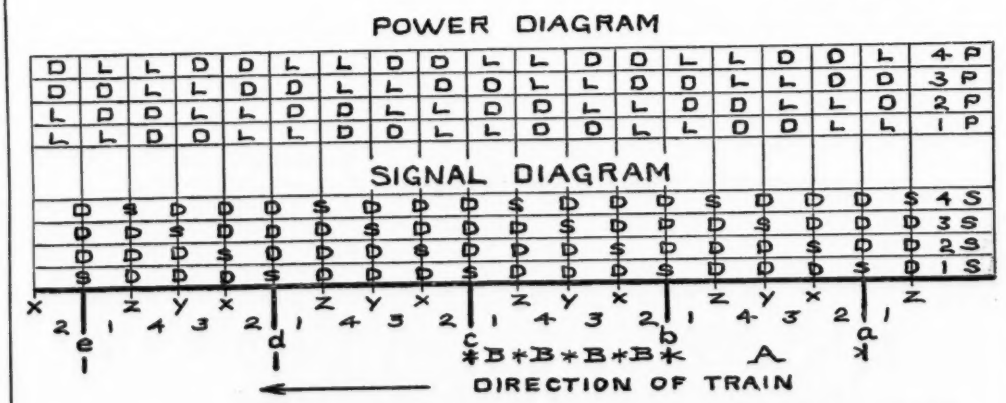


DIAGRAM OF COMBINATION BLOCK SIGNAL AND CURRENT SYSTEM

N.Y. + P.R.T.

A = m FEET = 4B B = n FEET

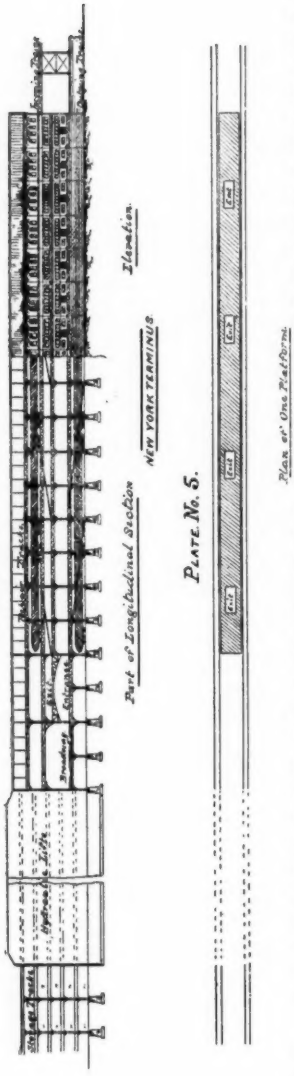


PLATE. No. 4.

PLATE. No. 5.

arrive and depart very frequently, and large crowds must be handled promptly and without confusion. To accomplish all these points requires that trains should arrive in one part of the station and depart in another; they must arrive and depart in rotation and always on the same track (also necessary to avoid accidents); passengers must move in the same general direction and forward, after once alighting or after entering the station for departing trains; these streams must never meet; passengers should always move on a level or down inclined planes; steps should never be used, and, if passengers must move upward to any extent, it should be by elevators. Such a terminal is suggested in Plate No. 4 (half elevation and longitudinal section) and Plate No. 5 (plan of one platform). The incoming tunnel would rise above the outgoing to the level shown; passengers would move down inclined planes and along to passageway to streets. The incoming train, after discharging its load, would move onto the hydraulic or electric lift and pass down to the level of outgoing tracks, or up to repair shops, or across to storage tracks; there could be one lift to each track. The outgoing passengers would enter the waiting-room at the street-level and pass down inclines to departing trains.

It seems from the foregoing that there are no difficulties in respect to safety or durability

of track sufficiently serious to prevent the attainment of a speed of 170 miles per hour. Our next problem is that of "equipment."

The feeder lines and ground return circuits could all be along the lines of present practice; our rails could, with their bondings, form the return circuit, reinforced, if necessary, by copper return feeders and connected by the metal ties. The outgoing and return transmission system could feed with multiphase currents to the signal towers at high potentials over wires carried as shown on Plate No. 2. At the signal towers rotary transformers could convert the current to direct, and then feed over copper wires to the various sections, the feeder switches being interlocked with and operated by the signal levers. Five central stations, situated respectively 6½, 24½, 42½, 60½, and 78½ miles from the New York terminal, could provide the power. Thus there would be a station close to the two points of maximum acceleration each 6½ miles from a terminal, or power stations could be located at signal towers omitting sub-stations. These power plants could be built according to modern practice, and could be tied together for the purposes of relay. It seems unnecessary to go into detail, as it is not suggested that present practice should be materially departed from. As this road will not carry freight, we need not consider item No. 4. Items No. 2 and 3 can be taken together, as every car should be a motor car capable of moving itself at the speeds required. Each car in a train would be like every other, except that the front and rear cars would carry at one end a hood or bonnet, as suggested in Plate No. 1, to reduce "head" and "tail" atmospheric resistance, and the front car would control the delivery of current to the motors. (It must not be inferred that the suggestion more than outlines a type which might have to be modified,—for example, by the use of guiding trucks.) The coupling and vestibuling of cars could be done by the present methods. The wheels being of large diameter (7 feet) and six to each truck, the cars should ride easily on such a track as the one proposed. These wheels could have wide treads and somewhat thicker flanges, of the depth of those now used, and could be built in sections to stand the high velocity. These wheels, at 170 miles per hour, would make 11.34 revolutions per second, or 680.4 per minute, which would not be excessive, so far as the motors are concerned. The axles could probably be made hollow, say 15 inches in diameter, with journals and boxes of the present standard; if the latter were made 10 inches long, the pressure would be only 166 pounds per square inch, though 200, or even 300, is allowed to-day with good results. Such wheels and axles should greatly reduce the rolling and axle-resistance of the train. The car might

be, in general characteristics, like that shown in Plate No. 1, seating 140 passengers and having doors on both sides for rapid loading and unloading; the windows could be of heavy fixed plate glass, and ventilation could be secured at the top and ends as now, with the addition of openings along the sides, under control of the passengers, like registers in houses heated by hot-air furnaces. The doors could be opened and shut from the ends of each car by a lever system similar to that used on the Intermural Railroad at the World's Fair, and under the control of the guard in each car.

In our outline we have, thus far, good reason to think that a speed of 170 miles per hour or more can be attained and maintained without any danger or inconvenience to the passengers; but we now come to the really serious questions at issue,—namely, what will our train resistance be at this high velocity, what horse power will be needed to overcome it, and what will be the distance within which a train, moving at this speed, can be stopped without inconvenience to passengers? A volume might be written on the first of these; so we will deal first with the second. Allowing 90 per cent. of the weight to be applied for braking purposes and an efficiency of one-sixth with 2 pounds rolling resistance, such a car running at 170 miles per hour could be brought to a stop on a level track in about 9,910 feet with present-day brakes. Assuming uniform retardation, this would be 3.139 feet per second. With a double system of brakes and track brakes, the proposed car could no doubt be brought to a stop in a much shorter distance without danger to the passengers, although perhaps with some inconvenience.

Train resistance can be divided into the following headings:

1. Journal friction, between journals and bearings.
2. Rolling friction, between the wheels and rails (No. 1 and 2 are usually considered together).
3. Atmospheric head resistance.
4. Atmospheric tail resistance (suction).
5. Atmospheric side resistance.
6. Atmospheric bottom resistance.
7. Atmospheric top resistance.
8. Oscillation and concussion resistance, increasing the journal and rolling friction. (Nos. 3, 4, 5, 6, 7, and 8 are usually considered together).
9. Curve resistance.
10. Grade resistance.
11. Starting resistance.
12. Stopping resistance.

In considering this question, it must be remembered that the

various recorded experiments differ widely, and show many seeming inconsistencies, as well as some real ones, and that many of the formulæ from reliable sources assume that "velocity resistance" is either all atmospheric or all oscillatory; furthermore, that these experiments have been made upon tracks and with rolling-stock which cannot be compared in character with those suggested, and have been conducted under the disadvantage of the locomotive's high resistance as compared with that of the train behind it. It is to be regretted that we have no more positive knowledge on this most important subject so far as it relates to very high speeds, and that, therefore, any conclusions we may come to must be more or less uncertain.

Taking up the resistances in detail (but not consecutively), we find first that experiments on European and American railways give journal and rolling friction from 2 pounds per ton as a minimum to 8 pounds as a maximum, the figures being based on axles averaging, say, 4 inches and wheels averaging 42 inches in diameter. These resistances vary directly as the diameters of the axles and inversely as the diameter of the wheels, and are not materially affected by the velocity; the lower limit would, give, therefore, a resistance of 2.7 pounds per ton for the proposed car, and the higher limit 10.9 pounds per ton. When it is remembered that the data we now have are for wheels, journals, rails, and track, any comparison of which with the proposed construction and equipment is like a comparison between one of our new western lines having 40-50 pound rails and a model English system having 100-pound rails, it is not unreasonable to predict that the resistance per ton of the proposed car will not exceed the lowest now known. It is not unreasonable because, though our records are from trucks, journals, wheels, etc., in fair condition for present practice, their maintenance is not up to the standard that will be absolutely necessary on the proposed road. We have already seen that the maximum curve resistance on the sharpest proposed curve will not exceed 7.5 h. p. per car ($\frac{1}{2}$ pounds per ton = 16.66 pounds per car). We have shown that the maximum grade requires 272 h. p. per car additional (4 pounds per ton = 600 pounds), which is partly balanced by the "velocity head" acquired by the train when running down grades; in our case, assuming the latter to be equal to $.04V^2$ (V = velocity in miles per hour; allowance being made for rotative energy of large wheels), we have, as a minimum from our profile for 20 feet vertical height, 22.3 miles per hour (89 h. p. per car, assuming 10 pounds per ton resistance), or, as a maximum for 40 feet vertical height, 31.6 miles per hour (126 h. p. per car, assuming 10 pounds per ton resistance, which is liberal). In starting the train it is proposed to have heavy down grades out of the terminal stations (these will also

help retard the trains on entering), the one at New York about 100 feet fall and that at Philadelphia about 80 feet. These grades would respectively produce "velocities feet" of about 50 and 45 miles per hour, and, assuming each to be half a mile long, it would take approximately 72 and 80 seconds respectively to attain those speeds. The necessary horse power to maintain a velocity of 170 miles per hour would be far in excess of any power required to start the train from rest, even assuming that it would be 40 pounds per ton (it would probably be less than this, and almost wholly instantaneous in character). Stopping resistance has already been discussed. We now come to atmospheric, oscillatory, and concussion resistances (Nos. 3, 4, 5, 6, and 7).

These resistances, commonly called "velocity resistances," vary enormously, depending upon the formula ; all experiments have invariably shown that at high speeds all formulæ known to the writers give far too high resistances,—⅓ to ½ too high at tested speeds, the errors being probably much greater for the high speed here contemplated. One source of error is the sometimes improper measurement of atmospheric resistance in pounds per ton ; for, with the same surface exposed at a given velocity, this resistance would be the same, irrespective of the weight of the moving body. Some writers credit to oscillation and concussion two-thirds of the total velocity resistance, and claim that air has far less effect than is commonly supposed. Some of the high resistances known in present practice should not exist with rotative application of power. Every railroad man is familiar with the "racking" in locomotives produced by the thrust of the rods quartering on each other ; the slight elevation of one rail would materially reduce the evil effect of oscillation, and the rotative application of power would reduce it still more. Atmospheric side, bottom, and top resistances are not of any great moment, except as effected by the velocity and direction of the wind ; the atmospheric head resistance should be greatly reduced, for the proposed train would have no surfaces exposed between the cars. There being no platforms or means of passing from car to car, and no sharp curves, the ends could be brought close together, and the small intervening space could be closed by a flexible "vestibule" at sides and top and bottom. The shape of the front end of the first car and the rear end of the last car could be made so as to materially reduce resistance from these causes. The atmospheric bottom resistance of present practice, due to exposed mechanism of every kind, together with present trucks, which tend to pocket the air, could be reduced by the smooth plane surface running the entire length of the train, with openings for only the lower part of the wheels. Oscillation and

concussion could be greatly reduced by precautions already suggested, and also by the greater rigidity and stability of the proposed track. Various formulæ give a variation of from 50 to 250 pounds per ton resistance for trains at the proposed speeds, or a variation of 3,400 to 17,000 h. p. for 150 tons (one car). The evidence seems to be strong that many existing formulæ are far from the truth, and that the resistance of the proposed train, on a line built as suggested, would be much less than many engineers now believe; exactly what it would be, it must be confessed, is somewhat problematical. The resistance of a train of several cars would be much less per ton of train than that of one car, because of the elimination of some of the velocity resistances of the cars following the first one.

Assuming that we had no grade to help accelerate the trains on starting, and that we increased the speed uniformly for six minutes over a distance of 44,827 feet, the acceleration per second would be .692 feet, while the horse power per car needed to effect this would amount to 1,450.

Our conclusion is that it is an engineering probability that such a road could be built and operated, without departing so radically from present practice as to make the chance of success less than that of failure. In the specific case discussed a careful study and the necessary surveys would lead to many changes and modifications that would tend to reduce not only the maximum power or speed required, but also the cost of construction. This project is no bolder in conception than was the Suez Canal, the Brooklyn Bridge, or the Manchester Ship Canal, so far as the engineering possibilities are concerned. The next paper will treat of probable cost, operating expenses, and receipts.

COST-KEEPING METHODS IN MACHINE-SHOP AND FOUNDRY.

By Henry Roland.

I.—THE ELEMENTS OF COST AND THE INFLUENCE OF WAGE SYSTEMS.

"PRIME cost" means the cost of stock and cost of labor added to all cash expenditures chargeable solely to account of the job or piece under computation.

"Total cost" means the entire cost of the job or piece under consideration, and is composed of the prime cost with a certain addition for its proportion of the "General Expense Account," as it is called in America, or the "Establishment Charges," as it is named in Great Britain.

Cost-keeping, or the ascertaining of prime cost and total cost, is not an indispensable requisite to success in foundry and machine-shop management, since many foundries and machine-shops have enjoyed long periods of high repute and great prosperity without the employment of any system of cost-keeping whatever, their managers having had the commercial intuition and ability necessary in order to demand and obtain prices leading to the accumulation of wealth without strictly-formulated business methods.

It is equally true that no elaboration of system will lead a badly-directed shop to success, and many failures have been marked by slavish adherence to those uselessly-attenuated forms of business detail which are the first resort of small executive powers when confronted with large and varied responsibilities. The clear-seeing manager is not inclined to load his mind with petty detail, or his office force with a wearying burden of minutely-ramified accounts, but, on the contrary, may wisely and rightly fall back on a method of broad averages, ensuring a tolerable approach to accuracy with a reasonable amount of book-keeping.

There is, however, abundant authority for detailed cost-keeping in the foundry and machine-shop. Books of respectable size have been written on this topic, and to some classes of really capable minds any approach to the uncertainties of guesswork in business details is an annoyance not to be endured, and a manager having a mind of this exact order is almost certain to make extraneous efforts toward exact cost-keeping. It is extremely difficult to reach the exact total cost of any article of manufacture because of the fluctuation of some of the factors which go to make up that cost, and the most

careful and painstaking manager may find himself baffled in his attempts to ascertain what is done in his own works, as is shown by the following recital.

In an establishment of world-wide reputation for one class of electrical instruments examples of wonderful uniformity in milled work were shown. Upon being asked the piece-cost of this admirable work the manager directed attention to a young man of much apparent intelligence who stood at one of the milling machines engaged on the work in question with a horse timer in his hand, recording the actual time of operations in progress in fractions of a second. "That young man," said the manager, "is a very bright young technical graduate. I do not know the cost of any single thing made in this place, but, if that young man lives, I shall be able to tell the cost of some things about two years from now—perhaps of a good many things."

Those two years having elapsed, this same establishment was recently visited for information in regard to accurate cost-keeping. The intelligent technical graduate with the horse-timer and fractional-second record was a thing of the past, and the manager had no information whatever to give on the subject of accurate cost-keeping, which is much to be regretted, as this manager is not a man to lightly abandon an experiment, nor is he likely to rest short of a close approximation to a desired result; his experience would undoubtedly be of great value, could he be induced to make it public.

But, although the estimating of exact total cost may be very difficult, or even commercially impossible, because of a too great attendant expense in record-making, it is not extremely difficult to closely approximate the total cost of a manufactured article.

The elements of total cost taken in their natural order may be listed as follows,—*viz.*, cost of raw material, and cost of labor, augmented by a certain percentage of the general expense account.

The expense account is inevitable, since a shop must exist before it can take and execute orders for finished product, and hence there are at the outset the three specified principal factors of total cost.

In respect to the cost of material and labor only, there can be no question, and no difference of opinion, generally speaking. The third factor of total cost, the percentage of expense, is open to wide variations, both in determining the elements which shall be held to rightly make up the expense total, and what percentage of that total shall be used as an increment of the stock-and-labor-cost of the manufactured article in question to give its total cost.

As the object of this series of articles is to aid in the reduction of machine-cost by the exhibition of shop methods actually employed by well- and widely-known establishments rather than by advancing

and maintaining any theoretical proposition whatever, the discussion of expense-account items will be passed for the present (although the formation of the expense account must in all cases precede the performing of actual work in the shop), and consider the stock-and-labor-cost by themselves, as separated from the total cost.

The first aim of the shop manager or superintendent who is immediately responsible for the cost of the manufactured articles produced is always directed to the reduction of labor-cost, not because labor is always or generally the largest element of total cost, but because the labor-cost is the one element which can be reduced. The expense account is not commonly under the control of the shop superintendent, but is determined by the general policy of the establishment. This policy may involve large advertising and travelling expenses, a credit system which must result at times in collection expenses and losses, and all those other large costs which arise from an aggressive business policy having for its first object the increase of territory covered and volume of transactions consummated.

But, while the policy of the shop may double or treble the total cost of manufactures produced, this policy is not subject to the control of the superintendent, who must therefore direct his attention to the lowering of prime cost by one of two methods,—either lowering the pay of the workmen, or increasing the workmen's output. There is absolutely no other way of reducing prime cost, and, in consequence, there are many different methods of recompensing workmen, each of which is believed best by those using it.

The most obvious form of labor recompense, and the method which actually underlies and governs all other methods, is the day-pay or hour-pay system, which assumes that an hour of the workman's time has a certain value, or "going rate," which may vary considerably for different localities, but is, generally speaking, maintained uniformly in each locality taken by itself, and is also modified in each locality in recognition of individual superiority, this modification, however, never reaching such an extent as to cover the difference in the actual value of the workman's efforts to the shop.

In the old times there were but two classes of "producers," or workmen, in the American machine-shop and foundry,—apprentices and full hands. "Sweepers," "laborers," "skilled laborers," and 'boys" have been added, and now form recognized classes of productive labor, the "boys" taking the place of the old apprentices in many shops, and being passed on into the full-hand list, if they prove bright and trustworthy, or rising no farther than the rank of skilled laborer if they are of the common turn of mind, content with small certainties. By means of this grading the hour-prices of day

labor are in many places made to differ very greatly. A boy at 40 cents per day or a skilled laborer at $1.25 per day often attends a machine which under the old order of things might have been managed by a full hand at $2.00 or $2.50 per day, and this brings the hour-price of labor much nearer its actual value to the shop than was possible with the "apprentice" and "full-hand" labor divisions only. But in the hour-rate pay system the workman's actual output is not first considered in fixing his wage. The "going rate" is the standard in all hour-pay decisions. If a hand asks for a raise, he is likely to be told that he is welcome to better himself, but the shop is paying already as much as it can afford, the manager knowing that the workman's hour-pay is up to the going rate, and that he cannot, if he is a mere ordinary hand of his class, obtain more by changing shops.

The final result of the going rate and hour-pay is to fill a shop which is well managed under that system with a working force of steady-going, orderly, well-disciplined men, who produce a moderate output of good work with great uniformity of labor-cost. To increase this output and ensure a certain fixed and unvarying labor-cost of output, the hour-rate of pay may be wholly abandoned, and a plain piece-rate may be substituted.

This piece-rate may be paid to one man for the work of many others under his management, the man who takes the work from the shop becoming a contractor, or the piece-rate may be paid directly to individual workmen in charge of a foreman who is paid a fixed salary.

Piece-work, though nominally ignoring time, and dealing with production only, is always referred to the going hour-rate as a standard, and here two diametrically-opposed practices originate. One practice is based on a theory of increasing floor-area production, or—which is the same thing—decreasing the expense percentage which must be added to the prime cost to obtain the total cost. This practice involves a fixed and unchanging piece-rate, based on the belief that it is more profitable to increase the workman's out-put than to decrease the piece-rate cost of labor. On the other hand, many excellent establishments omit all consideration of area production or large individual machine or individual workman production, and regard the going day-rate as the standard by which piece-rates are to be regulated. In accordance with this view, if a piece-worker is making very much more than the going rate,—that is, very much more than he could obtain elsewhere immediately,—the rate per piece is reduced so as to bring the workman's earnings nearer the going rate. The argument used to the workman to induce cheerful compliance is based on the fact that at the reduced rate he still obtains more

for his services than any other shop stands ready to pay him, because he must enter a new shop at the going rate for his class.

Both of these piece-rate policies are pursued with great success, as will be seen later, in the detail of the actual methods employed by individual shops in regulating the labor-cost of their productions.

The rate-fixing policies previously mentioned deal either with time considerations or piece-produced considerations only. There are two other methods of recompensing labor which consider both time and output. The first of these, which has been practised with highly favorable results for many years, makes two different hour-rates to each workman, the greater time-rate being paid if a certain piece-production is reached in a certain time, while the lesser hour-rate is paid if the piece production for the certain time falls below the limit. This difference in hour-rates is based upon the expense percentage which must be added to prime cost, or to the labor-cost, as may be, to produce the actual total cost.

To illustrate this point, which is perhaps not immediately obvious upon first consideration, suppose the addition to labor-cost for expense to be 75 per cent. of the labor-cost, which is much below the average. Suppose also (which is an actual case) that the two hour-rates adopted by the management are 27 and 30 cents, and suppose that a workman is required to make 10 pieces in 10 hours to win the 30-cent rate. Now, if a workman produces 10 pieces in 10 hours and obtains the 30-cent hour-rate, his 10 pieces cost for labor $3.00, and for expense $3.00 × .75 = $2.25, making a combined labor-and-expense-cost per piece of $5.25 ÷ 10 = $0.525 each. If another workman turns out 9 pieces in 10 hours, and obtains $2.70 for his labor, the total labor-and-expense-cost of his 9 pieces is $2.70+$2.70 × .75 = $4.72, making the cost of each one of the nine pieces $4.72 ÷ 9 = $0.5244 +, or, for all practical purposes, the same labor-and-expense-cost as that of the piece turned out by the more speedy workman. Hence this double hour-rate may be regarded as equalizing the pay of the workman in this example. Further consideration, however, shows that such is not the case. A given shop has room and tools, a capacity for the economical working of a certain number of men, irrespective of wages paid to each. The expense is a fixed sum, and hence, in case of workmen using the same tools, the expense is more fairly divided by a per man apportionment than by a percentage of the sum of wages paid. In this view of the matter, the workman producing only 9 pieces and earning only $2.70 should have 75 per cent. of $3.00 added to his wages-cost, making a total labor-and-expense-cost of $0.6333 + for each of the 9 pieces, as against $0.525 for the cost per piece of the speedy workman's production.

This simple example is carried out at length under the conviction that this matter of relative individual production of workmen as affecting total cost has not been fully considered by all, or even any large part, of the foundry and machine-shop managers of the United States, at least. It is a common thing to approve a manager who has a shop full of steady-going, medium-priced men, speaking of his management as economical because he does not pay unusual prices or endeavor to "force" his production. But the moment the influence of the expense account is brought to bear on the actual cost of the work produced by these faithful plodders, it is seen that such a labor equipment is of the most extravagant description, and that any system which increased the production would permit the payment of much higher wages while still greatly reducing the total cost.

The attention of foundry and machine-shop managers cannot be too strongly directed to the fact that every square foot of shop-floor must be regarded as an augmenting factor of the expense account, and the best management of workmen is that which produces the greatest output per square foot of floor and per hour of time, and that the maximum effects in these directions cannot be secured with low-priced men whose only aim is to escape discharge and reach pay-day.

The remaining method of labor recompense which recognizes both the lapse of time and the piece-production is known as the "Premium" system, because it is offered to the workman in such form as to appear to place the shop in the position of giving a bonus or premium in the way of a small hour-rate for every hour saved from an estimated time of performance of work. Thus a workman may have a job given him with a time-limit of 15 hours; if he finishes this work in 10 hours, he will also have a "premium" rate of 8 cents per hour paid to him for the five hours saved, making a total of 40 cents added to his regular day-rate for 10 hours. This premium system is a very safe plan for the shop, as will be seen from a detailed example given hereafter. The workman's reward is immediate, and the effect of the premium system in stimulating production is at once apparent in the increased activity and diligence of the operative. If the workman takes the full time-limit, or more than the time-limit, to complete the work, he suffers no penalty. He simply obtains his regular day-rate of pay, losing nothing and gaining nothing; hence he stands in the fortunate position of a possible gainer without risk to himself. Consequently no workman ever objects to the installation of the premium system in the shop where he works, and thus one of the initial objections to the establishment of a piece-rate system in a shop paying hour-rates is obviated. This premium system is commonly used with the understanding that a time-limit once established

on a certain piece of work shall not be lowered, which gives the same incentive for exertion as an unchanging piece-rate ; in both cases the workman knows he can exert himself to the utmost without jeopardizing his future rewards. The premium system has an advantage over the fixed piece-rate system in not so greatly increasing the workman's pay if the time-limit is over-estimated as by a too great piece-price estimate, because the premium system recognizes the actual time of performance as the principal factor of the workman's earning. The fixed piece-rate recognizes production only, taking no notice of time; hence, an overestimate of, say, 50 per cent. in the time on piece-prices would result in the piece-worker's doing a day's work in half an day, and thus winning double the wage intended by the management, while, by the premium system, the workman under an overestimate gains only a comparatively insignificant sum above his regular hour-pay. Hence the premium system is perhaps the easiest and safest of all changes from the hour-pay system.

It is certain that the relations between production and expense are not fully comprehended by all managers directly affected by those relations, and it is also certain that many managers who are vaguely aware that their own management might be improved by the introduction of a production-rate in some form are deterred from a serious consideration of such an adoption by the belief that the work under their charge is so varied as to make the fixing of fair piece-rates impossible. In the examples of actual shop practice which will be submitted in subsequent papers of this series, it will be seen that establishments doing a very considerable variety of work do fix piece-rates upon almost every item of their product. Those managers who have used the piece-rate systems for a long time assert with perfect confidence that there is no difficulty in fixing equitable piece-rates on work of any description, large or small.

It is asserted that the maximum rates of performance of machine tools are easily ascertained, and that, given the length and diameter of a piece of turning or boring, it requires but a moment's calculation to fix upon the very least time in which it can be performed on the tool to be used. So with drilling and planing, shaping, slotting, and milling. Given the thickness of chip to be removed, the number of cuts over, and the dimensions of the surface, any finishing cost can be estimated with perfect certainty, fixed percentages being used for the time of handling work, making ready, cleaning up, and replacing tools.

Undoubtedly to the mechanic who has had no experience in thus estimating work by computation the operation appears extremely complicated and uncertain. Any operative machinist, however, who is

accustomed to working against time to make the day pass quickly well knows the very great uniformity of time consumed in repetitions of the same operation, even when large surfaces are to be covered.

After the system of surface-finishing computation is once established in a shop, records accumulate with rapidity, and a rate-fixer with a fair memory speedily acquires such a stock of past performances as to be able to say, off-hand, almost exactly what time will be required to finish a piece of work which is entirely new to him. But there is not the slightest need for guess-work. Every machine tool has its maximum rate, and that rate cannot be exceeded under any circumstances; hence the piece-rate fixer has only to be certain that he adds enough to the least possible time of finishing to cover detrimental conditions to be certain that his estimate will not wrong either the shop or the workman. The efficiency of workmen bears no comparison for uniformity with that of machine tools, and time-limits which might give one workman high day-rates may give only very small pay to another, but in this case justice is done by the employment of the piece-rate; the poor workman obtains poor pay, and, although the shop pays more in all cases for work done by slow men than for work done by fast men, it is not so greatly wronged under the piece-rate as under the day-rate system.

Estimates of piece-cost may be, and often are, made by consultation of experts; this method is used both in small work and large work. There are no facts at hand on which to base any deductions as to the feasibility of making calculation estimates or prices of very-small-dimension work, and the piece-rate fixing on small milling and drilling, and all that class of machine work spoken of as "factory work," is more commonly the result of estimate from past records or from consultation. But it does not seem that any class of work offers any prohibitive difficulties in the way of rate-fixing by computation.

THE INDUSTRIAL AWAKENING OF THE RUSSIAN EMPIRE.

By F. J. Guyon.

ONE of the most significant tendencies of the age is toward the substitution of industrial for political prestige in the rivalry of the great nations. This is preëminently an era of industrial expansion, of the installation of machinery and the development of manufactures, and England, Germany, France, and, more lately, the United States, no longer finding the home markets sufficient for the consumption of the products of their machine-shops and factories or the home developments adequate for the full employment of their educated engineering talent, are turning their eyes toward newer lands, where the natural resources have been less fully exploited, and where there are larger fields, more abundant opportunity, and possibly richer reward for mechanical enterprise, engineering skill, and invested capital.

Under such stimulus the attention of Europe and of America has recently been directed toward Russia; not that Russia lacks excellent engineers and competent industrial managers, but that the country which is to be developed is so enormous that it will be impossible to make her wealth available without outside aid. To quote a recent article in *L'Illustration:* "Her natural resources are immense. Without speaking now of Siberia, whose exploitation will be the work of another generation, the coal-field of Donetz, which measures 25,000 square versts, is one of the largest in the world. The oil wells of Pennsylvania will be exhausted long before those of the Caucasus. In 1895 the Russian production was 400,000,000 pouds,* while that of the United States was but 236,000,000. Russia is literally another America; more ancient, but more recently discovered; newer in a sense, and equally propitious for colossal enterprises. She has her cotton kings, the Marosoff; her Ural kings, the Demidoff and the Stroganoff; and there is room, on this yet virgin soil, for many other kingships of industry and finance."

Concerning a field so important, it may be of value to give some general facts, drawn partly from official documents, due in part to the courtesy of fellow engineers, and in part derived from personal experience extending over a number of years.

* The Russian poud is about 36 pounds, or about 55½ pouds to the ton of 2,000 pounds.

The production of iron ore is constantly increasing, at the rate of about 10,000,000 pouds a year; so far as concerns the steel and iron made from this ore, however, the output of steel shows an increase of 27 per cent. and that of iron a loss of 2 per cent. per annum. Metallurgical activity turns more and more to the production of steel—an increase which is explained by the orders for the Trans-Siberian and other railways. On the other hand, the iron manufacture seems rather to be neglected, in spite of a fair demand, and a constant rise in price in the different grades is noticeable since 1890. This rise favors importations, and hinders the development of agriculture, to the detriment of the country; for cheap agricultural machinery is much needed.

Rolling of rails has chiefly occupied the Russian steel works, and in recent years their production has been:—

1891—1,650,000 tonnes.*
1892—1,800,000 "
1893—2,300,000 "
1894—2,500,000 "

Since the last date, the advance is still more marked, but is not officially stated.

In the Urals, the Moscow center, Finland, and Volhynia the furnaces run on charcoal. In Poland and South Russia, on the other hand, they use coke. In 1894 the relative production was in the proportion of 7 to 5 in favor of the charcoal iron (42,725,000 pouds, as against 34,536,000 pouds from coke furnaces). Since that time coke has undoubtedly been gaining much more rapidly than charcoal, and the coke production will soon be the larger; the statistics for 1893–94 leave no doubt upon this point. It is noticeable that the output of iron ore is not increasing to any important extent, except in the south, and there the production of iron remains stationary or diminishes, while steel-making is on the increase. Steel-making, on the contrary, is on the decrease in the Urals, and barely holds its own in Russian Poland.

The principal coal-mining centers are the Donetz basin, Poland, and the Urals. Siberia and the Caucasus are also rich in coal, but the bad condition of the roads or their almost complete lack of communication have so far hindered any thorough or extensive exploitation, and the coal production in those districts is unimportant.

The production of the Russian coal mines doubled between 1885 and 1894. Donetz, Poland, the Moscow district, the Urals, Siberia, and the Caucasus together produced 260,580,000 pouds (4,156,000

* The tonne, or metric ton, is about equal to 1.1 tons of 2,000 pounds.

tonnes) in 1885, and 526,785,000 pouds (8,432,000 tonnes) in 1894. Poland and the Donetz basin especially increased their coal production during this period, French and Belgian capital playing an important part in the development of the mines. On the contrary, the collieries of the Urals and the Moscow district are declining in their production. The inferior quality of their coal unfits them for replacing charcoal, as the forests disappear, and they cannot successfully compete with the excellent Donetz coals.

The fuel of the future seems to be petroleum or its residues, which is more and more used to replace coal in the region of Moscow, and even in many metallurgical works. Oil is so easy and clean to use, requires so little attendant labor, and is so easily regulated, that it seems destined to general adoption as fuel, especially as it gives more heat than coal. Its price, however, is high, and the manufacturers of Moscow have petitioned the minister of finance for a new railroad running to the Donetz field, so that coal may be sent thence at less expense to Moscow. Thus an acute and useful competition may reduce the price of oil throughout the region to a proper level.

Manganese mining is also on the increase, and the same is true of zinc; but copper shows a decline. Neither of the last two metals was produced in sufficient quantity for the demands of the country in 1894, and the importations were 12,000 tonnes of copper and 8,000 tonnes of zinc. The zinc industry is practically confined to Poland, although in the south and in the Caucasus there are important deposits, which no doubt will be developed later. At present, however, the expansion of the Australian and Belgian production has caused so great a decline that the price of sheet zinc has fallen rapidly from 4 k to 2.80 k, actually leaving no profit to the State *concessionaires* and licensees. But, when the Russian works shall have introduced the improved processes which they now lack, and can reduce their manufacturing expenses to the level of the foreign basis, the home industry will have no further fear of the competition of Belgium and Australia, and will easily realize profits of several million roubles yearly. At present but two companies are engaged, and they employ only about 1,400 miners and 700 workmen, in two sheet mills and a zinc-white factory. So far as the Polish production is concerned, the high protective tariff renders Silesian competition almost impossible.

From comparative tables published in the organs devoted to industrial and financial statistics, it appears that the Russian production of petroleum has been continually growing during the last decade, and that in 1895, for the first time, it exceeded the American output. The Russian total, which was but 50,000,000 pouds fifteen years since, reached 400,000,000 pouds in 1895, and one-quarter of this

was taken for export. In 1890 Russia produced 243,000,000 pouds, and the United States 355,000,000 ; in 1895 Russia produced 400,-000,000, and the United States but 236,000,000. In six years the total Russian output was 1,900,000,000 pouds against only 1,859,-000,000 from the United States during the same time. Especially since 1895 has the Russian yield surpassed the American, and entered upon an enormous increase.

Since 1872 the Russian government has abolished the monopoly. Following the year 1894, which had been very unfavorable, the department of railroads sought to favor exportations by two successive reductions of tariff. The situation was deplorable, prices abroad being very low. Indeed, the Americans threw an enormous stock on the market in 1893 ; it was not until the end of 1894 that the reduction of this stock, and the decrease in the American production, checked the decline, since which time an improvement in price has set in.

For some years industrial and engineering attention has been directed toward the south of Russia, and the Donetz basin in particular. Belgians and French have built important iron and steel plants, stamping works and machine-shops, coal and cement companies, glass-works, and other industries. A company has also been organized for the manufacture of explosives and chemical products, near Debaltzeno.

In a word, "Donetz" seems to be the rallying-cry for Russian industrial movements. It must be noted, however, that although there have been built in Russia within the last few years many large establishments for first operations, producing raw materials, there has not yet been erected that most essential complement to large works, the machine-shop capable of making on the spot the tools, repairs, changes, and additions which such work constantly requires.

The Ural district, being rich in minerals and especially in iron, has long had important works on both slopes. The principal industry in these establishments is the rolling of thin sheet-iron, measuring about .71×1.42 meters and about ½ millimeter thick. These sheets are in extensive use in Russia for roofing, being laid flat (after turning over the edges with a wooden mallet) and painted green or red. Iron in heavy sheet is also manufactured in these works, but in small proportion. Thus, out of a production of 20,000 tonnes of iron at Alapaepk, 15,000 were thin sheet, the remaining 5,000 representing plate and heavy sheet.

The works on the European slope, having mineral coal at their doors at lower cost than charcoal, use it in preference. The establishments of the Asiatic slope, on the other hand, employ charcoal exclusively for blast furnaces, puddling furnaces, and forges. The

iron which they produce is therefore of better quality, but more expensive. It could not be otherwise, since some of these works must bring all the wood, or charcoal, needed in the works a distance of fifty kilometers by special railway. Another cause of the advanced price is found in the amount of ready capital needed, which is necessarily great, for the wares are sold at the Nijni Novgorod fair, held but once a year.

Besides iron, the Neuianski works heat gold ores, and the Bogokowski works ores of copper. The latter also manufacture sulphuric acid and phosphorus, operate a glass works and a cement manufactory, and are installing a model plant for rolling steel rails.

All these manufactures depend on wood for fuel. The species of trees most abundant are firs and beeches. There are also lindens and aspens, but the commonest tree is the fir.

The Ural region is rich also in precious stones of all sorts—topaz, amethyst, chrysolite, garnet, emerald, aqua-marine,—indeed, all except the diamond.

It is in the industries dependent upon railways that progress in Russia is most needed. The Russian empire needs 10,000 locomotives and several hundred thousand railway wagons. Equipment is deficient at many points, and the crops suffer for lack of transportation facilities. Metallurgical works also are at times stopped by total exhaustion of their supply of fuel, which can not be replenished in time, owing to lack of necessary rolling-stock.

A single American company has taken an order for several hundred locomotives, of which one hundred are to be delivered in the shortest possible time. This order has involved the construction, on the banks of the Volga, of a shop employing 5,000 workmen.

Another establishment, of French origin but organized under a Russian name, has taken an order of equal importance for rolling-stock, and will keep many workmen busy for several years. The world will follow with intense interest the Russian industrial movement, which will be greatly accentuated upon the completion of the Trans-Siberian railway. This road will open to industry and commerce an enormous country whose richness, although well recognized, has so far remained undeveloped for lack of means of communication.

In the great competitive struggle now opening in Russia, a struggle between the genius and the methods of two continents and many nations, it will be most interesting to observe the victories. Ere long we can judge who have best succeeded in introducing their national industries into this new land whose needs are as vast as its territory.

There are likely to be two classes among the industrial immigrants,

—those who find a closed door, and those within, who have themselves closed the door to their rivals.

But this suggestion would be incomplete without directing attention to some suggestive remarks which conclude the article in *L' Illustration*, from which quotation has already been made. M. Normand, after reviewing the comparatively large extent to which French capital, usually most timid, has been embarked in Russian enterprise, adds: "Thus, what we scarcely do in our own distant possessions, we have begun to do in Russia. We are planting there colonies of engineers, of chemists, of skilled workmen, . . . and of capitalists. It is much to be hoped that this movement will be accelerated. If the Russian empire affords no market for our merchandise, which cannot there find a *clientèle*, it will at least extend warm welcome to the too-often-idle capital, the too-little-used energy, which abound in our land.

"Against importations from Germany and England, and in default of importations from France, French production, planted on Russian soil by the aid and for the profit of French capital, will at least contend with advantage. . . . French industry will be in its proper *rôle* when it aids industrial Russia in the struggle against an outside competition, in which French commerce has no part."

Without entering upon a politico-economical discussion, we may share M. Normand's vision of the splendid opportunities which Russia is opening for the exercise of the talents of the engineer, through the whole range of his profession, and for the introduction of the engines, the electrical machinery, and preëminently the machine-tools which represent the crystallized thought of the mechanician. "There is room, on her yet virgin soil, for many kingships of industry and finance."

EXPLORING AND EXPLOITING A GOLD COUNTRY.

By Albert Williams, Jr.

AFTER every new discovery of mineral which happens to be of sufficient importance to attract attention from the outside world, there follows in train, as a sort of logical sequence, a certain series of occurrences. To any one who has been on the spot at the time of a strike and its following rush and excitement, it is easy to foretell what would happen in a similar contingency. History never repeats itself so surely as in these stories of mining. At Wood River, at Creede, at Cripple Creek, to say nothing of the countless rushes of early California and Nevada times, it was just the same. First comes an account of a big strike, magnified by the rose-colored lenses of the prospector. No matter how honest a man, if he once happens to light on a good find it is sure to grow multifold in his sight.

After the first news of such a strike, a number of enterprising prospectors start out for the locality, hoping to find something equally good. With them go some people of the sutler class who propose establishing shops,—general merchandise stores, they are called. This movement is, of course, reported in the papers, and attracts the attention of a larger crowd of persons, who might be called enterprising, but are mainly shiftless. This is the beginning of the rush proper. The next move is by transportation and supply companies, who do not hesitate to exaggerate the reports from the new districts, and, in the cases of Creede and Cripple Creek, owning also the newspapers, kept on lying long after there was any hope or chance for the tenderfoot incomers. For it does not take long for all the ground that is at all promising to be "located," and often covered with thousands on thousands of claims, many of them overlapping and conflicting, out of the whole number only a very small proportion ever amounting to anything. It is only natural to expect that the early comers should select the best ground; in some cases the original discoverers have taken everything worth having. This would apply, however, to a district of limited size, as, for example, the Bonanza and El Dorado Creek portions of the Klondike region, rather than the wider and more varied area of possibly mineral-bearing ground included in the whole newly-discovered placer country.

In these big mining rushes the later comers usually fare very

badly. To obtain some idea of what the proportion of disappointments generally is, it should be remembered that at both Virginia City and Leadville there were more than one hundred thousand persons at one time, while at Creede and Cripple Creek, which happened to be more easily accessible, men came and went in such numbers that there was no way of estimating their total number. The rushes to Boise Basin (Idaho) and the Black Hills (South Dakota) involved great hardship, hardly, if any, less than the present Alaska movement, to which was superadded the danger from hostile Indians; yet the prospectors, the traders, and the camp-followers poured in by thousands. It is worth considering how very few out of all these thousands ever acquired real mining ground, or even employment. In every case on record there have been from ten to a thousand unsuccessful ones to each who succeeded. It was so in the early days of California, where all the conditions were ideally favorable; but in California and other places more favored by nature than Alaska there was room for the disappointed ones to do other things than mine. In the latitude of the Arctic circle, and inland, there is little else to look for than mining and the few industries depending upon it,—transportation, timber-cutting, etc.

Now, as to the Klondike country this same thing is being repeated. Besides the usual small games, and the larger ones of transportation and the sale of outfits and provisions, we find another usual accompaniment—speculation; just as, after the wealth of the Rand became known, London was flooded with promoters and corporations offering shares, so now we see the Klondike opportunities being seized upon. In a reputable paper now before me I find a column and a half of advertisements of Yukon and Klondike and Alaska corporations, in none of which appears the name of a mining man of whom anybody has ever heard. The most reasonable scheme proposed is that of establishing a line of steamboats and going into trading business in anticipation of next year's promised rush. That project will be forestalled by the exertion of the shrewd ship-owners of Seattle, Tacoma, San Francisco, and Victoria, whose light-draft boats are now building, and will be ready when the season opens.

Another beautiful plan advertised is the tempting proposal of some very new women to "man" a schooner yacht, sail around the Horn, and arrive in Alaska some time in futurity.

But among all these advertisements I find none so open to criticism as the proposition "to acquire and operate mining claims;" and this is what nearly all of them point to.

Those who would never think of going into the collar-button and necktie business, and are willing to confess their ignorance of the

technical details of that trade, are still willing to stake their money in mines. They seem to regard the business as a sort of lottery, in which the chambermaid has an equal chance with the financier.

It always seems foolish to attempt predictions about new mining fields which one has not even visited. Yet in this case there are some things which can be safely said. There are several mining experts in the Klondike country who will have to winter there, and will have from now until next June to look at the ground. They will find, for one thing, that there is no particular Klondike; that the discoveries are in many separate camps; and that the whole territory about which we get these almost fabulous reports is a very big one.

So there is no one special point to look for. In fact, any explorer would be bothered by the multiplicity of richness, in the same sense that a prospector in Montana, Idaho, or Colorado is perplexed by finding colors in any pan from any creek. Finding traces of fine gold proves nothing in a country where there are innumerable quartz veins of no value, but which contribute their float to mislead the prospector.

So far, what gold has been taken out in the upper Yukon country has come from shallow placers, running from ten to twenty feet deep, with the best pay, as usual, on the bed rock. In the short season there has been some hydraulicing, but most of the "get" has been by more primitive means.

From all one can learn, it will not take long to work out the rich, shallow placer-ground in any one locality. Afterward there will be a period of quartz-mining. Whether the upper Yukon country is destined to rival Nevada county, California, or Gilpin county, Colorado, or the Transvaal Rand, is something no one knows. Supposing it to be equal, as regards the mineral conditions, nevertheless the climate and the distance from supplying points are adverse. So far as the actual mining goes, when it comes to underground work climate does not count. Where it tells is in the matter of transportation.

If the mining men now in the Yukon country are wise, they will cease looking for phenomenally rich streaks in small placers, and will search for the original quartz veins from which these placers have been made. The gold of the Klondike and Stewart river countries is coarse, indicating a short journey from its original source. It was to have been expected that some important discoveries of lodes would be made before now, but it seems that all attention has been paid to the placers. As to these finds in river beds, they have very likely been equalled by those in Boise Basin, in California Gulch, and in many other places, the difference mainly being in the coarseness of the Yukon gold. This coarseness seems to have put a queer idea into

the illustrators of *Puck*, which for two weeks printed pictures of supposed gold pans with gratings in their bottoms, the scheme evidently being, to the artist's mind, to screen out the small gravel and mud, retaining only the big nuggets.

But we must not look disdainfully on the gold pan. It, or some similar appliance for testing by washing, is the only available means for estimating the value of gravel, which of course it would be absurd to assay. Although its work looks so rough, in reality, in experienced hands, it gives wonderfully accurate results, so that it is not only used with gravel, but is by many considered far better than the fire-assay for gold-bearing quartz, when the ore is pounded up, screened and washed in it. Formerly it was used wholly for getting gold; now it is used for testing and for cleaning up small lots of particularly rich stuff. It is the implement with which the future exploration of the Alaska gold fields will be effected.

Theoretically everyone knows by this time the art of exploring and exploiting a gold country. It has been so well acquired that a handful of men can overrun a wide territory in a few days, and locate all the placer-ground worth taking up. The idea, for quartz, is simply to follow up the gulches and cañons wherever the pan shows the color; to stop when the indications cease or lessen; and then to skirmish in the side or end hills for a lode. All of which looks easy on paper. In practice, however, if one is prospecting in a "mineral" region, colors are found everywhere. Then it is necessary to use the pan, not as a mere means of finding gold, but as a means of estimating how much,—that is, it becomes an assay, though closer than any assay.

After experimenting with the horn spoon, saucers, Riotte spoon, the batea, pointed tumblers, and all sorts of appliances, it is my opinion that there is nothing to compare with the old, original, California 20-inch gold pan, stamped out of one piece of sheet iron, with an angle of, say, 30° and no crease in the bend. With this tool, and a five-minute instruction, but with considerable experience, one can rapidly reach a rough estimate of the value per ton in gravel or pounded rock. That is something which the fire-assay cannot do for the prospector.

It is a great convenience to have two gold pans or else one pan and a bucket, so as to save time. In this way the rough work can be done rapidly, the small stuff containing the gold being thrown together into the other receptacle, the prospector keeping in his mind a tally of the number of pans. A heaped pan-load weighs about twenty pounds, so that one pan represents the hundredth part of a short ton. It is easy to acquire the habit of picking up uniform pan-loads. With gravel, the amount of the pan-load depends somewhat on the

size of the stuff, all moderate-sized pebbles being washed and allowance being made for boulders, which requires judgment. In testing pounded quartz, the most convenient weight is ten pounds, or the two-hundredth of a ton. A larger weight of gravel can be used,—fifteen to twenty pounds. The knack of gaging the quantity is easily acquired, all that is necessary being to determine on some convenient aliquot part of the ton or cubic yard, the latter ranging between one and one-half and one and three-quarter tons, so that a pan will stand for the 100th, 150th, 200th, or other fraction, with allowance for boulders. When using two pans, after taking enough samples, all the small lots of concentrates in the second pan are together washed carefully over the first pan, the overflow tailings rewashed, and the aggregate result carefully cleaned by drying, removing black sand by a magnet and winnowing off the rest of the waste. When the amount of gold collected is considerable, it is weighed in the most delicate balance available. Estimating "colors" is a different matter, as a small fraction of a cent makes a showing to mislead the novice. With a little practice and advice from an old hand, this art also is mastered.

It is by means of this sort that the Yukon country will be prospected and developed. At present it is going through the stages that early California went through. The rocker, the tom, and the short sluice are there. Hydraulicing and booming have, so far, been conducted only on a small scale, and, as the open season is so short and the gravel so shallow, this kind of mining cannot last long. The future is in the quartz.

Perhaps the best way to "size up" a "rush" is to remember what has happened in others. About once in three years an excitement of this kind occurs in the mining community. That it extends now to the outside public is due to greater newspaper advertising.

It has always happened that, after a great mining excitement and its accompaning speculative fever, there has been a sharp reaction, often a crash and a temporary set-back, with a slow recovery. Afterwards a district that has been over-boomed, and then underrated, settles down to its normal level in the opinion of investors, and work goes on less feverishly and more successfully. Some of the mining corporations which will be engaged in really exploiting the new Yukon mines will doubtless pass through the same experience. As for the catchpenny schemes, the sooner they are exploded the better for Alaska. But there is little doubt of there being real and substantial merit somewhere in all that vast new area, or areas, so that it is passible that there may be worthy rivals of the great Treadwell, so far Alaska's single heavy gold producer.

If there are such mines in the far north, it will require extraordinary effort to get in machinery and supplies, and to put them in shape for active production. Little, comparatively speaking, is needed to outfit a small placer,—sometimes only the crudest appliances, such as some lumber whip-sawed or turned out by a small saw mill on the spot, supplemented by a nozzle or two and a few hundred feet of canvas pipe. But to equip a big hydraulic mine, supposing there to be warrant in the ground for putting in an extensive plant, involves heavy expense for transporting the miles of large steel or iron piping and other metal fixtures required.

Supposing that the prospecting for the quartz lodes, from which the placers already discovered were derived, should reveal something in the nature of a big mine, or mines, it is not a necessary sequence from the richness of the gravel that the veins should be small and high-grade ones, for which moderate plants would suffice, involving even in this case freight charges amounting to several times the cost of the machinery at the foundry. The famous gold quartz mines of the world have been, and are, of moderate down to very low-grade ore. In fact, the most productive have been of extremely low-grade, but having large deposits. So, judging from analogy, if really great quartz mines are to be found and properly developed in the new regions, we shall see some achievements in rapid equipment and overcoming of disadvantages which will almost put the celebrated work on the Homestake (Black Hills) mine to the blush. In the last mentioned case a railroad—engine, rails, and all—was hauled in by wagon teams hundreds of miles from the nearest railroad. A modern plant for a big gold mine is something to look at with respect, with its heavy hoisting, haulage and pumping equipment, its huge mills containing hundreds of stamps, and its constant heavy renewals and supplies. Low-grade mines have to be worked on a very large scale to render a profit. So, if there are to be new Homestakes or Treadwells up the Yukon, there will be some nice engineering that is not mining.

It is a great pity that, no matter how successful the new districts turn out to be, provided they are successful at all, the public will have lost interest, and the newspapers will not devote space to describing the most interesting part of the work. Next season it will be an old story. But, if the work this fall, winter and spring reveals a small fraction of what the shouters promise, there will be some hustling in Alaska, though the general public will hear little of it.

PROGRESS IN THE PERFECTION OF THE RACK RAILWAY.

By E. L. Corthell.

COMPARATIVELY few persons, perhaps, realize the importance which the rack railway has attained, not only as a highly-perfected engineering construction, but as an effective economic development. That which, barely a quarter of a century ago, was regarded as a curiosity of engineering, ingenious rather than practical in its tendencies, has made quiet, but steady, progress in perfection and application, until it commands general respect, not merely for the financial interests directly involved, but for its value as a factor in transportation problems and in the development of hitherto difficultly accessible regions.

Seventy seven of these railways, some for passengers alone and some for commercial purposes, carrying passengers and freight, have been put into operation in different countries of the world. It is an appropriate time to review the history of this development, especially as a rack railway is now projected which surpasses all others in boldness of conception.

It is not generally known by visitors to Lucerne, Switzerland, that living and working quietly at his home in the center of that city is the engineer whose name is seen on rack locomotives all over Christendom,—the designer and builder of the "Système Abt," Monsieur Roman Abt, one of the most accomplished civil engineers in Europe. The travelling world is indebted to him for overcoming, for purposes of transportation, some of the most serious physical obstacles to access to the most impressive viewpoints in the mountains. The writer has thought it no more than just to Mr. Abt, and of sufficient interest to the readers of THE ENGINEERING MAGAZINE, to so analyze the history of rack railways as to place by themselves the twenty-nine roads built by Mr. Abt or under his general direction.

The advantages of the combined rack and adhesion system will be stated, in the hope that this method may consequently be applied in many cases where railway managers are now undecided how to surmount great elevations for commercial purposes, like those from the low-lying Tierras Calientes of Mexico to the table-lands, from 8,000 to 10,000 feet above the level of the sea. Then will be described the great tourist road, now in the initial stages of construction, to surmount the Eiger, Mönch, and lofty Jungfrau, in the mountains of Switzerland.

History has repeated itself in the rack railway, and yet the history of the steam railway lies entirely within the limits of the nineteenth century. So marvelous, however, have been the rapidly-progressive developments, and so important results have come, and are still coming, from the comparatively recent developments of electric traction, that it appears to be centuries since Trevethick astonished the people of London by appearing on the streets with a road locomotive. The next year (1804) a locomotive of his design hauled a coal train up an incline in South Wales. This locomotive ran on iron rails, but, notwithstanding his great inventive genius and original ideas, he made a mistake that retarded the development of the railway until Bracket discarded the erroneous idea in 1814. Trevethick, and other engineers as well, believed that the wheels would slip on the rails, if protruding nails were not driven in that part of the tread of the wheel that overhung the rails, to indent themselves into a wooden exterior surface. They believed that smooth wheels on rails apparently smooth would not produce sufficient friction to overcome the force of gravity of the train-load on even moderate grades. For this reason Blenkinsop, in 1811, built, near Leeds, a real rack-bar railroad. But it did not work satisfactorily. Bracket then made a practical experiment to prove the efficiency of adhesion-friction. Following him came George Stevenson, who built the first engine to produce traction by adhesion. In spite of the incredulity of people, he, with his "iron horse," in 1819, hauled trains of coal-cars at a speed of four miles per hour. From this grew the great adhesion systems of the world, now employing nearly eighty thousand locomotives. The time came, however, when the adhesion principle reached its useful, and even practicable, limit in surmounting steep grades. The friction of the driving-wheels on the rails became less than the sum of the resistances required to haul the train. It became evident that we must either turn the mountains into plains,—an impossible task,—or else build a motor that would not depend on its weight to overcome steep inclines.

Thus, after a little more than half a century, we came back to Trevethick and Blenkinsop. But it was not in old, but in New, England, that the mountains were first scaled by a rack railroad. Sylvester Marsh, in 1861, attempted to prove the practicability of reaching the top of Mount Washington, New Hampshire, 6,268 feet above the level of the sea. But it was with the greatest difficulty that money could be found for such an untried experiment; so that it was not until 1869 that he completed this work and began to take people to the mountain-top. His success made it possible for Riggenbach, of Switzerland, to raise his money, and soon the Rigi-kulm was reached by a similar railroad. As a matter of considerable historic interest, and to show by contrast the

INDEX NUMBER	ROAD	COUNTRY	SYSTEM	DATE BUILT	ELEVATION ABOVE SEA LEVEL				GAUGE		LENGTH				MAXIMUM GRADIENT	NATURE OF TRAFFIC	MAXIMUM TRAIN LOAD
					LOWEST		HIGHEST				RACK		TOTAL				
					FEET	METERS	FEET	METERS	FEET	MILLIMETERS	MILES	KILOMETERS	MILES	KILOMETERS			
1	Middleton-Coal Mines	England	Abt	1812					4'-8½"	1435	3.5	5.6	3.5	5.6	1 in 9	F	64 tons
2	Madison-Indianapolis	United States	Cathcart	1847					4'-8½"	1435	1.3	2.1	2.0	3.2	1 in 21	F	60 tons
3	Mt Washington	" "	Marsh	1868	1682	512.5	6288	1917.2	4'-8½"	1435	2.8	4.4	2.8	4.4	1 in 4	P	77 tons
4	Rigi-Vitznau	Switzerland	Riggenbach	1871	1440	438.9	5741	1750.0	4'-8½"	1435	4.3	7.0	4.3	7.0	1 in 4	P	20 tons
5	Ostermundigen	"	"	1871					4'-8½"	1435	0.4	0.6	1.0	1.6	1 in 5	F	100 tons
6	Habelnberg	Austria	"	1874			1489	454.0	4'-8½"	1435	3.4	5.5	3.4	5.5	1 in 4	F	40 tons
7	Schwabenberg	Hungary	"	1874			1230	374.9	4'-8½"	1435	1.9	3.1	1.9	3.1	1 in 4	F	35 tons
8	Arth-Rigi	Switzerland	"	1874	1378		5741	1750.0	4'-8½"	1435	6.1	9.8	6.1	9.8	1 in 4	P	13 tons
9	Aerschach-Heiden	"	"	1874	1312		2472	753.9	4'-8½"	1435	3.4	5.5	4.3	7.0	1 in 10	P	35 tons
10	Wasserallfingen	Württemberg	"	1876					3'-3⅜"	1000	0.1	0.2	1.9	3.0	1 in 25	F	25 tons
11	Aeiti	Switzerland	"	1877					4'-8½"	1435	0.1	0.1	0.4	0.6	1 in 10	F	18 tons
12	Loufen	"	"	1878					4'-8½"	1435	0.1	0.1	0.2	0.3	1 in 5	F	18 tons
13	Friedrichshafen	Germany	"	1886					3'-3⅜"	1000	0.6	0.8	1.1	2.0	1 in 10	F	10 tons
14	Sólyo-Tarjan	Hungary	Locomotive	1891					2'-7⅝"	790	2.5	4.0	3.6	5.8	1 in 10	F	18 tons
15	Nordorf-Copper Mines	Germany	"	1888					2'-3½"	678	0.1	0.2	1.5	2.4	1 in 8	F	20 tons
16	Petropolis	Brazil	Riggenbach	1882					3'-3⅜"	1000	3.1	5.0	3.1	5.0	- Nil	P&F	20 tons
17	Green Mountains	United States	Marsh	1869					4'-8½"	1435	2.3	3.7	2.3	3.7	- 300	P	7 tons
18	Drachenfels	Germany	Riggenbach	1883					3'-3⅜"	1000	0.3	1.5	0.3	1.5	- 200	P	13 tons
19	Carcovado	Brazil	"	1883					3'-3⅜"	1000	2.3	3.7	2.3	3.7	- 300	P	8 tons
20	Rüdesheim	Germany	"	1884					3'-3⅜"	1000	1.5	2.4	1.5	2.4	- 200	P	14 tons
21	Degerloch	Württemberg	"	1885					3'-3⅜"	1000	1.2	2.0	1.2	2.0	- 170	P	11 tons
22	Zaharota	Hungary	"	1895					3'-3⅜"	1000	2.6	4.2	3.4	5.5	1 in 12	P	18 tons
23	Bismarcksaussen	Germany	"	1895					3'-3⅜"	1000	0.2	0.3	0.2	0.3	- 200	P	14 tons
24	Naples	Italy	"	1896					4'-8½"	1435	0.1	0.2	0.3	0.5	1 in 20	P	23 tons
25	Langres	France	"	1897					3'-3⅜"	1000	0.4	0.6	0.5	0.8	1 in 30	P&F	17 tons
26	Salzberg	Austria	"	1897					3'-3⅜"	1000	3.3	5.3	3.3	5.3	- 200	P	9 tons
27	Pilatus	Switzerland	Locher	1888	1447	441.1	6791	2069.9	2'-7⅞"	800	2.3	4.6	2.3	4.6	- 400	P	3 tons
28	Brünig	"	Locomotive	1888	1657	505.2	3084	1004.3	3'-3⅜"	1000	5.6	9.0	10.0	16.0	1 in 12	P&F	35 tons
29	Hollenthal	Baden	Bissinger	1888					4'-8½"	1435	4.5	7.2	23.7	38.1	1 in 16	P&F	30 tons
30	Padang	Sumatra	Riggenbach	1889	478	145.8	7000	2133.6	3'-6"	1067	18.0	29.0	32.9	53.0	1 in 25	P&F	60 tons
31	Petersberg	Germany	"	1889					3'-3⅜"	1000	0.7	1.2	0.7	1.2	- 200	P	9 tons
32	Achensee	Austria	"	1889					3'-3⅜"	1000	2.2	3.5	3.9	6.3	1 in 16	P&F	16 tons
33	Berner Oberland	Switzerland	Locomotive	1890	1871	570.5	3404	1037.6	3'-3⅜"	1000	2.7	4.4	14.5	23.4	1 in 12	P&F	40 tons
34	St Gallen-Gais	"	Klose	1890			3015	919.0	3'-3⅜"	1000	2.2	3.5	8.7	14.0	1 in 9	P&F	60 tons
35	Oporto	Portugal	Riggenbach	1891					5'-5½"	1670	0.4	0.7	0.6	1.0	- 125	P&F	40 tons
36	Neuenburg	Switzerland	Locomotive	1892					3'-3⅜"	1000	0.3	0.6	1.1	1.7	1 in 7	P&F	18 tons
37	Hauen-Lichtenstein	Württemberg	Klose	1892					4'-8½"	1435	1.4	2.2	21.1	33.9	1 in 10	P&F	100 tons
38	Madeira	Madeira	Riggenbach	1892					3'-3⅜"	1000	2.2	3.2	2.2	3.2	- 200	P	9 tons
39	Valamerosa	Italy	Telfener	1892					2'-7⅞"	800	2.2	4.2	2.2	4.2	- 222	P	9 tons
40	Barmen	Germany	Riggenbach	1893					3'-3⅜"	1000	1.2	1.6	1.2	1.6	- 166	P	12 tons
41	Sulmona	Italy	Locomotive	1893					4'-8½"	1435	2.2	4.2	7.2	12.0	1 in 10	F	35 tons
42	Wengernalp	Switzerland	"	1893	2621	799.0	6778	2066.2	2'-7⅞"	800	11.2	18.0	11.2	18.0	- 200	P	9 tons
43	Schynige Platte	" "	"	1893	1327	404.5	6464	1970.5	2'-7⅞"	800	4.5	7.2	4.5	7.2	- 200	P	9 tons
44	Monte Carlo	Monaco	Riggenbach	1893					3'-3⅜"	1000	1.6	2.5	1.6	2.5	- 250	P	9 tons
45	Sumatra	Sumatra	"	1893	—	—	—	—	4'-8½"	1000			15.0	30.0	- 167		
46	Iechach	Germany	"	1893					3'-3⅜"	1000			2.1	3.3	- 250	P	
47	Chamonix-Mer de Glace	France	"	not completed	3445	1050.0	6339	1932.0			1.7	2.7	3.0	4.8		P	
48	Jungfrau	Switzerland	Strub	"	6705	2044.0	13669	4166.8	3'-3⅜"	1000	9.4	15.1	9.5	15.3	- 250	P	

Note.- In the next to last column, above, "P"= Passengers only; "P&F"= Passengers and Freight, and "F"= Freight only.

TABLE I. SUMMARY OF RACK RAILWAYS. RIGGENBACH AND OTHER SYSTEMS.

INDEX NUMBER	ROAD	COUNTRY	DATE BUILT	ELEVATION ABOVE SEA LEVEL				GAUGE		LENGTH				MAXIMUM		NATURE OF TRAFFIC (See Key at foot of page)	MAXIMUM TRAIN LOAD (GROSS TONS)
				LOWEST		HIGHEST				RACK		TOTAL		ADHESION	GRADIENT PER CENT.		
				FEET	METERS	FEET	METERS	FEET	MILLIMETRES	MILES	KILOMETRES	MILES	KILOMETRES				
1	Harz Railway	Germany	1885	650	198.2	1652	503.8	4'-8½"	1435	4.7	7.1	19.0	30.5	3.5	6.4	P+F	135
2	Lebosten	"	1885					4'-8½"	1435	0.8	1.3	1.7	2.7	3.5	8.0	F	50
3	Oertelsbruch	"	1885	1834	559.0	2111	643.4	2'-3⅝"	690	0.4	0.7	3.1	5.0	5	13.	F	7
4	Puerto Plato	Venezuela	1886	1512	460.8	2256	687.8	3'-6"	1067	2.4	3.8	2.4	3.8	—	8.0	P+F	60
5	Mt. Generoso	Switzerland	1890	905	275.8	5237	1596.7	2'-7½"	800	5.4	9.0	5.6	9.0	—	22.0	P	10
6	Visp-Zermatt	"	1890	2144	653.6	5281	1609.7	3'-3⅜"	1000	4.7	7.5	21.7	35.0	2.8	12.5	P+F	45
7	Manitou-Pike's Peak	United States	1890	6604	2013.0	14196	4327.0	4'-8½"	1435	9.3	15.0	9.3	15.0	—	25.0	P	18
8	Eisenerz-Vordernberg	Austria	1890	2268	691.2	3950	1204.4	4'-8½"	1435	9.0	14.5	12.4	20.0	2.1	7.1	P+F	120
9	Transandine	Chile	not completed	5052	1540.0	10860	3310.0	3'-3⅜"	1000	17.4	28.0	46.7	75.0	2.4	8.0	P+F	60
10	Sarajevo-Konjica	Austria	1890	787	240.0	2887	880.0	2'-6"	760	12.4	20.0	34.3	56.0	1.5	6.4	P+F	70
11	Diakophto	Greece	1891	33	10.0	2343	714.1	2'-4½"	750	2.2	3.6	14.3	23.0	3.4	16.1	P+F	16
12	Rothhorn	Switzerland	1891	1883	574.0	7448	2270.0	2'-7½"	800	4.9	8.0	4.9	8.0	—	25.0	P	9
13	Glion-Naye	"	1891	2257	688.0	6240	1902.2	2'-7½"	800	4.9	8.0	4.9	8.0	—	22.0	P	10
14	San Domingo	West Indies	1891	33	10.0	2133	650.2	2'-6½"	765	4.0	6.4	22.4	36.0	4.0	9.0	P+F	50
15	Mt. Salève	France	1891	1339	408.0	3747	1142.0	3'-3⅜"	1000	5.6	9.0	5.6	9.0	—	20.0	P	19
16	Usui-Toge	Japan	1892	1275	388.6	3080	939.0	3'-6"	1067	5.3	8.6	6.8	11.0	2.1	6.7	P+F	100
17	Revard	France	1892	866	264.0	4918	1499.0	3'-3⅜"	1000	5.7	9.2	5.7	9.2	—	21.0	P	10
18	Montserrat	Spain	1892	460	140.1	2349	712.4	3'-3⅜"	1000	4.9	8.0	4.9	8.0	—	18.0	P	20
19	Schafberg	Austria	1893	1650	503.0	5691	1734.6	3'-3⅜"	1000	3.7	6.0	3.7	6.0	—	25.0	P	9
20	Begruf-Damascus	Syria	1894					3'-5"	1050	19.8	32.0	86.6	140.0	2.0	7.0	P+F	100
21	Trawnik-Bugojno	Austria	1894	2017	614.9	2546	776.3	2'-6"	760	3.9	6.3	26.0	42.0	1.4	4.6	P+F	120
22	Salgo-Tarjan	Hungary	1895					2'-1"	635	0.1	0.2	2.0	3.2	3.4	14.0	F	12
23	Snowdon	England	1895					2'-7½"	800	4.5	7.3	4.5	7.3	—	18.3	P	16
24	Tiszolez-Zolyom	Hungary	1895	1437	438.0	2384	726.6	4'-8½"	1435	3.7	6.0	26.0	42.0	2.8	5.0	P+F	175
25	Schneeberg	Austria	1896	1830	576.0	5876	1791.0	3'-3⅜"	1000	6.2	10.0	6.2	10.0	—	28.0	P	14
26	Gornergrat	Switzerland	1897	5305	1617.0	9902	3018.3	3'-3⅜"	1000	6.2	10.0	6.2	10.0	—	27.0	P	14
27	Hernadthal	Hungary	1896	1221	372.0	1240	378.0	4'-8½"	1435	0.2	0.3	0.8	1.3	2.0	10.0	P+F	32
28	Peñoles Silver Mines	Mexico	1897	1870	570.0	3166	965.0	2'-6"	760	1.9	3.0	6.2	10.0	3.0	15.0	F	14
29	Mt. Lyell	Australia	1896					3'-6"	1067	4.7	7.6	14.4	23.3	2.1	6.3	P+F	50

Note:- In the next to last column, above, "P" = Passengers only; "P+F" = Passengers and Freight; and "F" = Freight only.

TABLE 2. SUMMARY OF RACK RAILWAYS. ABT SYSTEM.

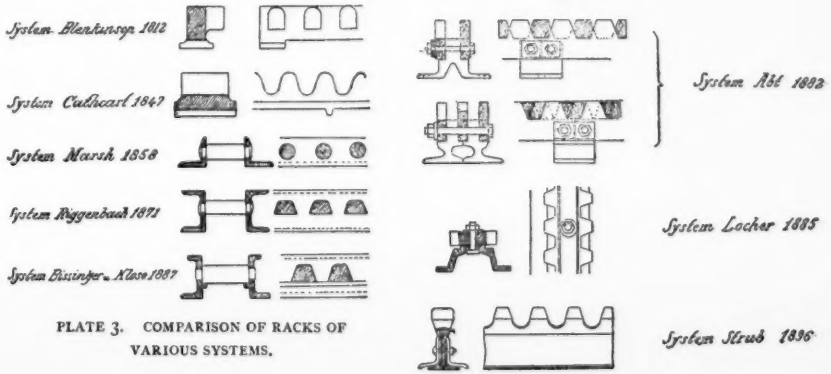


PLATE 3. COMPARISON OF RACKS OF VARIOUS SYSTEMS.

development of the rack railroad, a brief account of this Mount Washington road will be given.

In 1857 Marsh applied to the State legislature for a charter, but the project was regarded as the dream of a madman, and it was only after repeated applications that he obtained the charter. It is on record that a member of the legislature said: "Do not let us waste time in this discussion. If the man wishes a charter to build a railway to the moon, let us give it to him." The style of this first rack is seen in the comparative sketch of various systems (Plate 3). The early engines had vertical boilers, 10 feet high and 4 feet in diameter, with the old petticoat form of smokestack. The weight of the engine was six tons, and, working under normal conditions, it was able to push six tons of load to a height of 3,586 feet above the starting-point.

Compare this picture with that of the recently-built Abt locomotive, weighing 80 tons, for the Hungarian railway now under construction (Plate 8).

The late Mr. W. W. Evans stated in 1874, in forwarding a paper by the late Mr. Otto Gruninger, describing the Mount Washington railway: "I have had it translated (from the German manuscript) so that I could send it to the Institution of Civil Engineers, to be put on record there for the benefit of the members interested in mountain railways, and as a proof that Mr. Sylvester Marsh was the inventor of all the chief features of this system, and not Mr. Riggenbach. In claiming for Mr. Marsh the invention of the chief features (except the rack rail and cog wheels, which belong to Blenkinsop of many years ago), I mean its application to very steep gradients, the air brake, the type of locomotive used, and much of the detail of engines, cars, and track, as now copied and used on the Rigi railway. They belong to Mr. Marsh." The secretary of the Institution appends a foot-note to the abstract (published in 1888) of the original paper of M. Gruninger, as follows:

"The foregoing description, written twenty years ago, is now of little more than historical interest, the permanent way and rolling-stock of the Mount Washington railway having been since almost entirely remodelled, with the result that little of the original work, except the road-bed, now remains. It is, however, deemed appropriate to record in these pages some particulars of the first mountain railway worked by rack-and-pinion, the work of Sylvester Marsh, a man of singular tenacity of purpose, who had to struggle against great difficulties in the execution of his cherished design, and whose name has not been generally associated with the rack system."

From these early, but successful, attempts to build and operate

mountain rack railways have come about seventy-five others of many kinds and of many countries, besides cable and electric mountain lines. As Mr. Schneider, the general manager of the Harz railway, stated in a very interesting paper at the Chicago congress in 1893: "The rack principle, which, in the infancy of railroading, owed its invention to error, has now risen to great practical importance, furnishing as it does the acknowledged safest and most economical means of moving railway cars over steep inclines."

To give details of each of the seventy-seven rack railways now in operation would require a volume, and it would be well worth while to compile the data and to draw useful conclusions from the operation of these roads. It will suffice now to present two tabulated statements (Plates 1 and 2), one entirely devoted to the Abt system, and the other to several other systems. There are essential differences between the various methods. The advocates of each system have apparently sound arguments for their designs, derived from the almost universal freedom from accident on all of these mountain railroads, and from the ease and economy of their operation. The difference in methods consists mainly in the rack and the necessary adaptation of the motor to it. There is given, therefore, a combined sketch of these various forms of rack (Plate 3). The Cathcart plan was applied to the first rack railway for heavy traffic,—a short stretch of railway between Madison and Indianapolis,—in 1847; the maximum grade was about 6 per cent., but since 1868 it has been worked by adhesion altogether. The Locher system was designed by Col. Locher, of Zurich, the engineer who had charge of the Mount Pilatus railway, near Lucerne, the steepest railway in the world,—48 per cent. The Strub system is to be used on the Jungfrau railway, described later, and is the design of Mr. Strub, the chief engineer. The other systems need no further reference. The difference between the two leading systems, the Abt and the Riggenbach, is seen in the two photographs (Plates 4 and 5). There is also shown a photograph (Plate 6) of the Mount Pilatus double-toothed rack.

By far the most important application of the rack-and-pinion method is that used first on the Harz railway in Germany for ordinary commercial purpose. It is still an excellent model for adoption elsewhere. This railway runs from Blankenburg to Tanne, and combines adhesion on grades less than 2½ per cent. with adhesion assisted by rack on steeper grades. It was not until this successful solution of the problem that the people in this extensive country of mountain and valley gained communication with the outer world for themselves and their products.

It will be seen from the comparative sketch of the rack systems

that Mr. Abt's rack is not built in ladder-form, like that of Marsh, Riggenbach, and others of that class, but of two or more steel plates, set on edge, with spaces cut out of them in which the pinions of the locomotive engage, so that there may be more than one pinion at work; also, that the teeth of the multipartite racks are staggered. If two racks are used, the spaces, and consequently the teeth, are set so as to break joints, and the tooth of one plate is opposite a space of the other. If three plates are used, the teeth break joints at one-third of the pitch apart. The Abt locomotive is one of the simplest and, at the same time, most effective and economical motors ever designed for so extraordinary purposes. Its working is easy, and the wear of the plant is almost inappreciable. As an illustration of the most advanced type of Abt locomotive, and to show how powerful it is for freight purposes, an outline sketch is given of a locomotive just designed for a Hungarian railroad (No. 24 of the table of Abt railways). This locomotive weighs about 80 tons. It will haul a train load of 180 tons on a 6 per cent. grade, or 200 tons on a 5 per cent. grade, equivalent, respectively, to six or seven American cars loaded (Plate 8). A photograph of one of the Harz mountain locomotives is also given (Plate 7). Comparing it with locomotives used on most other rack railways, one is immediately struck with its great simplicity. The outside cylinders which move the adhesion driving wheels operate through the whole length of the road. Before the locomotive passes upon the steeper grades, where the rack is used, the two inside cylinders which move the rack pinions are set at work. Mr. Abt has designed a mechanism for allowing the pinions to take the rack easily by setting the first section of the rack on springs (Plate 4). While the rack varies in dimensions on different roads and under different conditions, it is usually made of rectangular plates, about 8 or 9 feet long, $4\frac{1}{8}$ inches high, with a width varying with the work it has to do. The plates are usually set as far apart as the the thickness of the plate. This construction forms one continuous rack-bar, and has no weak point, as there are no joints opposite each other. This form of rack is easily adapted to any curve that the car can run on, and allows of very sharp curves. It is the experience on the Harz mountain railway that the contact of rack teeth and the pinion gear of the locomotive is so nearly perfect that the wear on the teeth is practically *nil*, and that on the cogs of the wheel exceedingly small. The calculated wear on the teeth is $\frac{1}{25}$ inch in 150 years, and the cog-wheels will wear 12 years before replacement. Diagrams, showing the wear of cogs in eight years, prove the correctness of these statements. The cost of maintaining the rack is so small on the Harz railway that it has been eliminated as a subject of accounts. The great advantage of

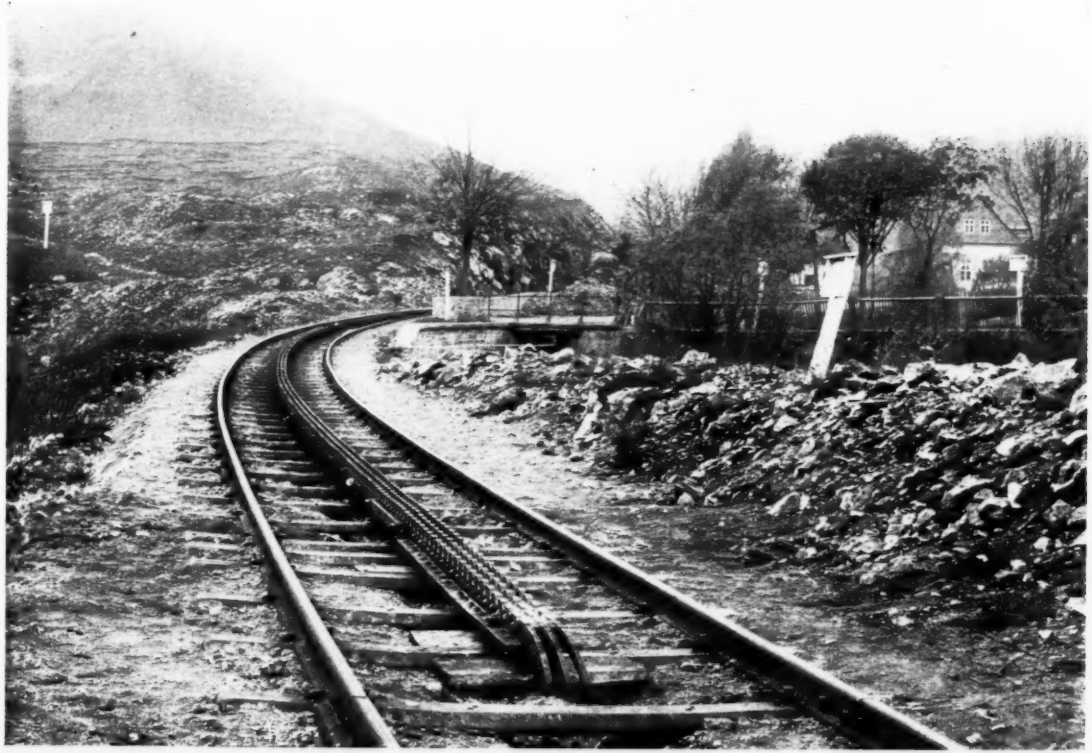


PLATE 4. RACK OF ABT SYSTEM. HARZ MOUNTAIN RAILWAY.

the Abt system of rack is that the strength can be made unlimited by increasing the thickness of the plates and by multiplying them. The system has the further advantage that, owing to the staggered position of the teeth, several thus working simultaneously, great speed can be safely obtained,—say, 15 miles per hour on a 6 per cent. grade. The expense of construction and operation is much less than the corresponding expense in the case of a developed adhesion road surmounting steep inclines. It may be stated, in general, that a rack engine will develop more than twice the tractive power of an adhesion engine. The following table is made up from observations of actual operations.

Grade.	Load per ton of Service Engine Weight.	System.
1 in 28	2.5	Adhesion
1 " 27	2.02	"
1 " 25	1.39	"
1 " 16.67	2.14—2.45	Abt rack
1 " 12.50	1.66—2.35	"
1 " 8	1.55	"
1 " 6.6	1.41	"
1 " 4.	0.78	"

A comparison of the cost of operation on the Harz railway with that on the Semmering railway, an Austrian adhesion road, gives the following:

Cost of raising 1000 foot-tons of load on the Harz mountains..... 4½ cents.
Cost of raising 1000 foot-tons of load on the Semmering.. 6 "
Metric measure:
Cost of raising 1000 meter-tons of load on the Harz mountains..... 0 844 frs.
Cost of raising 1000 meter-tons of load on the Semmerling..... 1.125 frs.

Several comparisons between adhesion roads of more than 2½ per cent. maximum grade and combined rack and adhesion roads prove that the advantage of the latter on essentially through commercial lines is expressed by a ratio of more than two to one, and that, as the grade steepens beyond 2½ per cent., the ratio of advantage rapidly increases, since the ability of the adhesion system to haul loads rapidly decreases with the increasing grade; also the possible speed, so that the cost per ton hauled rises very fast. But the great economy of the rack railroad appears in the comparative cost of construction between the same termini. The line of the adhesion road

would be more than twice as long, and the cost per mile very much greater. Comparing four adhesion roads in the mountainous countries of Europe with four mixed rack and adhesion roads, we find the former costing nearly four times as much.

An important project now to be undertaken, after several years of discussion, furnishes a good illustration of the advantages of the rack and adhesion method; I refer to the Simplon Tunnel line. The maximum rack grade is 6 per cent., the maximum adhesion 2½ per cent. The entire line is to be operated by electric motors. Its

PLATE 5. RIGGENBACH LADDER RACK. BRÜNIG PASS RAILWAY.

PLATE 6. LOCHER DOUBLE SIDE RACK. MOUNT PILATUS RAILWAY.

length is to be 31 miles, and the estimated cost $8,000,000. The estimated cost of a purely adhesion line is $18,000,000.*

The above observations on the combined rack and adhesion method are corroborated by the report of an important Italian commission, appointed by the Italian State office of public works:

*Since this paragraph was written, information has come to hand that the plan has been changed to adhesion alone, requiring a tunnel 11¾ miles long. Political and similar reasons—not economy in construction—led to this change.

"After having thoroughly studied this subject, we have come to the final conclusion: 1, that rack railways offer an excellent means for overcoming steep inclines which are beyond the limit of adhesion, and that they make railroad communication profitably possible in mountainous regions where adhesion roads would require the investment of too much capital, and would not pay.

"2, that the slow speed of the rack locomotives is favorable for working the engines most economically, and that the speed, though in itself slow, is, relatively considered, about the same as the average speed on adhesion lines.

"3, that it is practicable, considered from a mechanical stand-

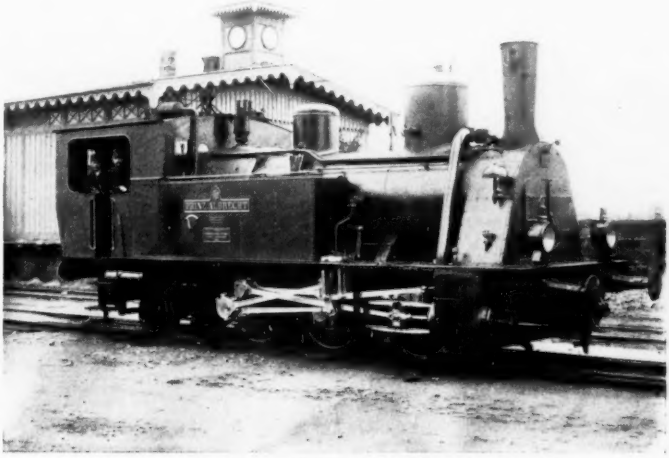


PLATE 7. ABT LOCOMOTIVE, HARZ MOUNTAIN RAILWAY.

point, for cog-wheel locomotives to ascend grades from 3½ to 25 per cent.; but that, from an economical standpoint considered, the grade on combination rack roads with large traffic should not exceed 7 per cent.

"4, that the Abt system for roads with large passenger and freight traffic is preferable to any other rack system.

"5, that the efficiency of a rack railway, even on very steep grades, is considerable, but on grades of 6 to 7 per cent. its efficiency is equal to an adhesion road of 2½ per cent.

"6, that the total operating expenses of a combination rack railway are smaller than those of an adhesion road between the same points; hence, that rack systems can favorably compete with adhesion lines.

"7, that Italy contains many locations where the application of the Abt system would be advisable from a technical as well as from an economical point of view."

We now come to the greatest rack railway project of the age,—the Jungfrau road, which, from its lower terminus at Scheidegg (the summit of the existing rack railways from Lauterbrunnen and Grindelwald), will almost immediately get into the region of snow and glaciers, and reach a height of 13,668 feet, a total rise from Scheidegg of 7,000 feet.

PLATE 12. ROUTE OF EXISTING RACK RAILWAYS AND NEW JUNGFRAU ROAD.

NOTE.

Existing Rack Roads ————————

Jungfrau Road — — — — — — — —

Electric Conductor - - - - - - - - -

Scale, 1:50,000.

A wealthy business man of Zürich, Mr. Guyer-Zeller, is the projector, promoter, *concessionaire*, and financier of this important work. He has employed, for the examination and study of the many difficult conditions, able engineers, thorough scientists of international reputation, and photographers. The map (Plate 12) shows the mountains, the glaciers, the snow-covered slopes, the steep, bare, rocky cliffs, the sloping foot-hills, the lovely lower valleys, and the two perennial ice-cold streams formed from melting snows and glaciers,—the White and Black Lütschinen, the one flowing by Lauterbrunnen, and the other starting in the mountain valleys near Gründelwald. It also shows the present rack railways, one leaving the adhesion road at Zwei Lütschinen station, the other at Lauterbrunnen. The first reaches Gründelwald, and the other the same place, by way of Scheidegg, the summit of the present lines. The broken line following the general course of the rack railways is the electric conductor for the Jungfrau line, which will carry electricity from the 6,000-h. p. plant, converting by turbines the water power of the rivers named.

The new road starts from Scheidegg. It is laid in the open—embankment or excavation—for a distance of 1½ miles, as shown by the full line. At this point, after skirting the Eiger glacier, it strikes into the mountain, the face of which is nearly vertical, and continues there for nearly a mile, by a gallery,—that is, a tunnel with numerous slight openings, and, in places, lateral tunnels leading out to open air near by. The section of the tunnel is shown on Plate 10. The line gradually sweeps around the Eiger, but, before changing its course to go due east, a station and outlook, a windowed apartment, is cut into the solid rock (Plate 11). With a spy glass from Gründelwald, these three or more windows will appear very much like a distant view of swallows' nests in a remote sand-cliff.

Then the line, still in tunnel or gallery, swings entirely around to the south side of the Eiger. In the vertical face of this side will be excavated another portal station with windows from which a view one hundred miles southward may be had, and a look down into a mass of green glaciers. Then, continuing in a south-westerly direction, the line strikes the Mönch, under whose summit it is proposed to tunnel out to the daylight for a view in that direction. Thus far the grade rises 25 per cent. Now, to reach the Jungfrau, following what is really a ridge between the two mountains and avoiding the deep glacial valleys, the line descends on a 10 to 12 per cent. grade, and then, by a straight 25 per cent. grade, ascends to a point about three hundred feet below the Jungfrau summit, which is reached by an elevator. The profile (Plate 13) shows the grades and the portion in tunnel or gallery and in the open.

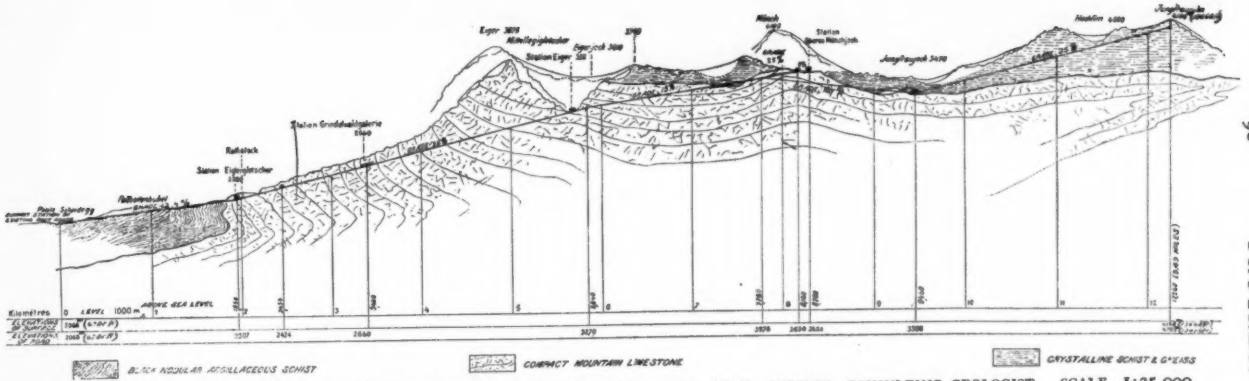


PLATE 9. JUNGFRAU RAILWAY. GEOLOGICAL PROFILE OF THE PROPOSED LINE, BY H. GOLLIEZ, CONSULTING GEOLOGIST. SCALE, 1:25,000.

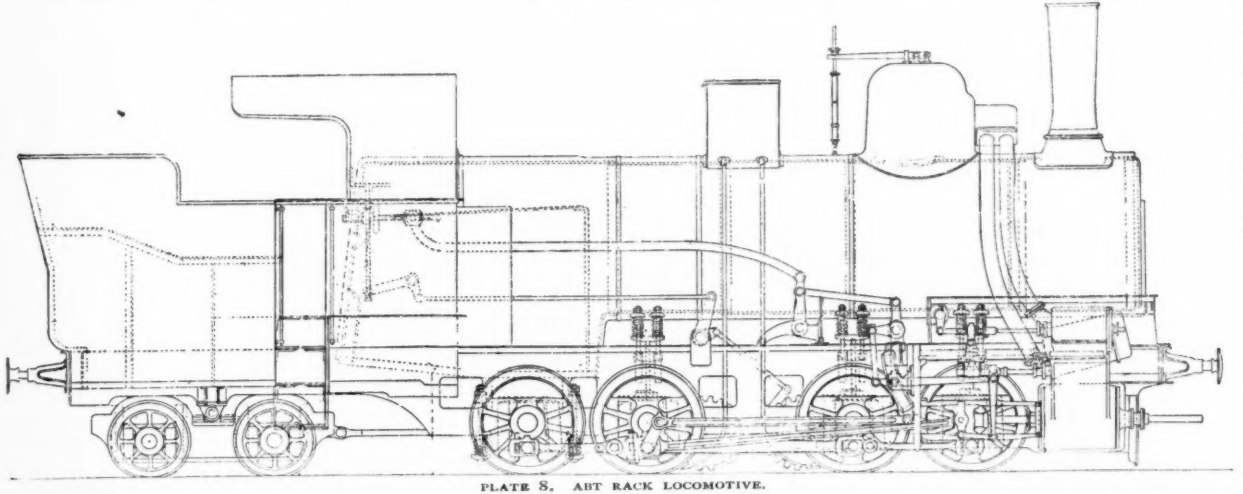


PLATE 8. ABT RACK LOCOMOTIVE.

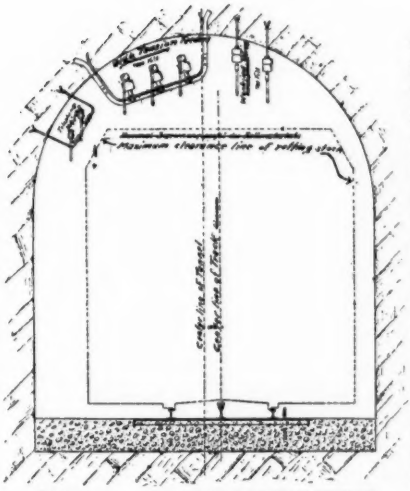


PLATE 10. JUNGFRAU RAILWAY TUNNEL SECTION.

Area of section 1356 sq. met. (145,959 sq. feet). Scale 1:40.

The comparative sketch of rack plans (Plate 3) shows the rack to be used. The cars will be moved by electric power. The tunnels and galleries will be lighted by incandescent electric lights (Plate 10). The cars and stations will be lighted (and heated when necessary) by electricity, and the tunnels and galleries will be pierced by electric drills.

The materials to be excavated are as follows, according to the report of the well-known geologist, Prof. Golliez, of Lausanne University, and Dr. C. Moset, of Zürich: compact mountain limestone from the second kilometer to beyond the highest point on the Mönch, at about 8½ kilometers; then crystalline schist and gneiss to the top of the Jungfrau (Plate 9, geological profile).

While the proposition for a concession was before the federal parliament and council, the subject was thoroughly investigated. Scientific opinions on "mountain sickness" were given by the topographical engineer, Mr. S. Simon, of Basel, the well-known aeronaut, Mr. E. Spelterini, a committee of the Swiss Alpine Club, Prof. P. Regnard, of Paris, and Prof. Dr. H. Kronecher, of Berne. Without going into the details of these voluminous reports, it is sufficient to say that,

acting upon them, the federal government saw good reasons for granting the petition for a concession.

As to the possibility of mountain sickness, there seems to be no further necessity for a scientific discussion on that point, as the summit will not be as high as some others already attained by railroads without harm to passengers or to laborers and others engaged in the work or in the operation of the lines. The highest point, as has been stated, is 13,668 feet above sea-level, and about 7,000 feet above the summit of the existing line at Scheidegg. The Pike's Peak railroad, which has been in successful operation for about four years, carrying many thousands annually to the summit of the mountain from Manitou Springs, is 14,087 feet above sea-level and 7,517 feet above the starting-point at Manitou. The Oroyo Railroad, in Peru, rises from sea-

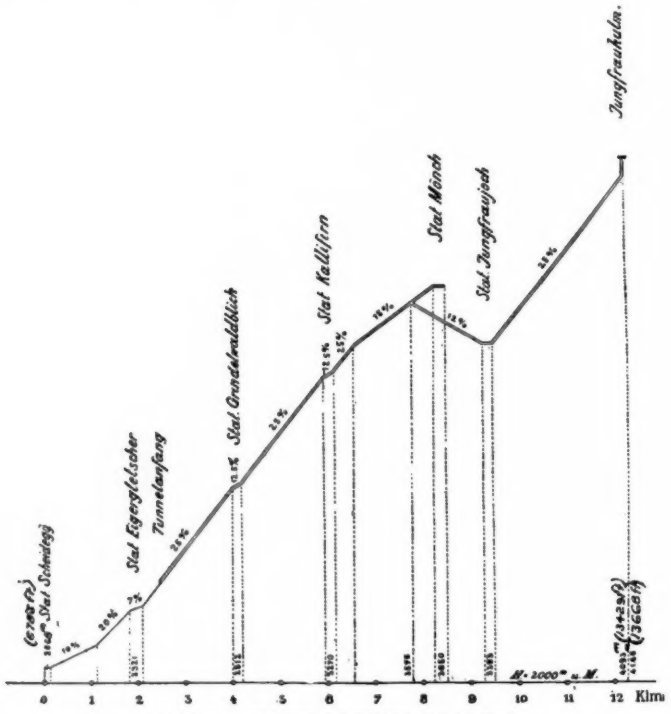


PLATE 13. PROFILE OF JUNGFRAU RAILWAY.

Scales, 1 : 100,000 Horizontal; 1 : 20,000 Vertical.

level to the summit (15,720 feet) in a very few hours. Several railways in Mexico, the United States, and Canada surmount summits more than 10,000 feet high without injury, or even inconvenience, to passengers. These facts settle that question effectually.

The cost of the entire road and equipment is estimated at $1,930,000. It is to be in operation to some of the lower stations within two years, and to the top of the Jungfrau in about 1902. These estimates, as well as those of traffic and income, were made by a commission composed of some of the most experienced engineers and managers of Swiss mountain railroads. If the construction and operation are placed in the hands of such men, unquestionably the results will be satisfactory. The traffic and income estimates made by this commission are in great detail and extremely conservative. Of the 160,000 visitors at Interlaken in the season of 1895, when the estimates were made, it is estimated that only 10,000 will reach the summit of the Jungfrau. But, as the numbers visiting Interlaken increase now at the rate of about 30 per cent. per semi-decade, and as the Rigi rack railway carried, in 1895, 112,913 passengers and the Mount Pilatus 40,841, the Jungfrau will certainly carry to the summit, in 1902, more than 10,000 tourists, for its advantages from a scenic point of view far exceed those of any other mountain railroad in the world. The concession authorizes a maximum fare, to the summit and return, of $8.68. The average fare actually to be charged is $6.75. The fares to intermediate stations are based on this, and fixed in proportion to the distance travelled, the altitude, and the importance of the station. On this basis, the total receipts from passengers, freight, restaurants, use of water power, etc., will amount to $139,346. Working expenses, renewals and reserve fund, and interest at 4 per cent. on obligations of $1,200,000, amount to $86,850, leaving, for the share capital of $800,000, a dividend of nearly 7 per cent. The writer is of the opinion, after a careful examination and study, that the financial returns will considerably exceed this amount.

THE DISTRICT DISTRIBUTION OF ENERGY.

By Charles E. Emery.

THE distribution of water through aqueducts and pipes for domestic purposes was familiar to the ancients, and in modern times has grown to be of great importance also to manufacturers. The distribution of illuminating gas through pipes has long been well established, and its use for cooking, and to a less extent for heating, is extending. The question of a separate distribution of fuel gas has been frequently discussed; local distributions have been made for power; and in isolated cases natural gas has been distributed and used for fuel. Steam has also been distributed for both heating and power. In later years the distribution of electricity for lighting and power has advanced with wonderful rapidity. In addition to these forms of energy distributed continuously through pipes and metallic conductors, interest is ever and anon awakened by plans for the transfer of energy in bulk, renewable at intervals, such as storage-batteries charged with energy at a source of power to give out light and power through suitable means wherever conveyed. More familiar is the periodic distribution, in enclosed vessels, of compressed gases for lighting and power. A late modification provides for the production of a brilliant light from acetylene gas generated on the premises in tanks containing "calcium carbid" produced electrically where power is cheap. All these are to be compared with the very homely, but wonderfully effective, distribution in bulk of coal, the greatest storehouse of natural energy,—"black diamonds" indeed, for energy sufficient to supply several horse-power for an hour can easily be carried by a child in a paper bag. All the various subsidiary energies enumerated can be developed by the combustion of coal, and it is a matter of convenience and economy that such energies are severally developed in large quantities, at special stations, for general distribution.

The question naturally arises whether all the methods of distributing energy referred to will survive in the future, it being naturally suggested that one or more will be developed so as to be applicable in a majority of cases for all demands, thereby practically displacing the others. Upon investigation, however, it will be found that each is useful, under proper conditions, in a particular location. It is our purpose at this time to endeavor to ascertain such conditions, for all methods, in a general way, and specially with reference to the district distribution of steam.

We may first consider that heat for cooking, and hot water for culinary purposes, are necessaries of life. In frigid and temperate climates the heating of buildings is at times a necessity. Light is also a necessity, and power derived from nature's stores of energy has, to a greater extent than we can discuss here, released man from the slavery of early existence, and made the higher developments of our modern civilization possible.

The methods of securing these necessities may be briefly outlined as follows:

Heat for cooking, so readily derived by the direct combustion of wood or coal, may also be obtained from illuminating and fuel gas, and to a large extent from steam, as explained hereafter. Heat from electricity is also available, with some drawbacks.

Light, familiarly produced by burning grease or oil of animal or mineral origin through a wick, is also furnished by illuminating gas and electricity.

Power is readily obtained by the use of steam or gas, and is transmitted readily from any source of power by electricity.

Illuminating gas is produced cheaply, on a large scale, but the generating plant and distributing pipes are expensive, and the capitalization more so, so that, by the time the gas reaches the consumer, there is strictly no economy in the light derived therefrom compared with that from refined oils. Gas, however, is so convenient that, wherever available, it to a large extent displaces all means of producing light from a wick, even in the houses of those of moderate means; and its growing advantages for cooking purposes give it a position from which it will probably never be displaced.

Power is also secured by the use of illuminating gas in gas engines; and for very small powers, or those used occasionally, the cost is not prohibitory. Power has been obtained in England and France by the construction of special gas plants generating a cheap fuel gas on the premises, which is used in gas engines. Some of these plants are of several hundred horse-power, and include a gas generator and gas holder, as substitutes for a steam boiler, and a gas engine instead of a steam engine. The economy is authoritatively stated to be superior to that of a steam engine, but engineers in the United States do not understand why, in that case, the system has not been more largely introduced.

Electricity is available for lighting and to distribute power, but must first be generated at a central station by the combustion of coal, or at a distant waterfall, and transmitted with losses increasing greatly with the distance. The cost of plant and transmission, and generally also of coal, with the inevitable capitalization expenses, make the cost

of electric light greater than that from gas. With the incandescent lamp, however, the heat is inconsiderable, and the light is so convenient, and in every respect so desirable, that no modern office-building, store, manufactory, or city or country residence of the very wealthy class, is considered complete without it. Municipal lighting and that of large buildings and areas are secured by means of the electric arc. Moreover, with electricity, power in any desired quantity may be transmitted through metal conductors with entire satisfaction, and with relative cheapness. Electricity has, therefore, come to stay, but cannot, in all locations, displace other means.

It has been shown that electricity may be practically used for heating and even for cooking. The cost, however, is prohibitory, and it is not at all likely that the price of current will be reduced sufficiently to make this method of securing heat an active competitor with steam and gas.

The transmissions in bulk renewable at will are mere modifications. So there remains only the question of the distribution of steam. Cooking by means of boiling can be performed perfectly and economically with steam. Meat may also be roasted in a closed metallic vessel. In the open air, however, the temperature of steam, ordinarily transmitted, is not sufficient to finally scorch the meat and produce the pleasant aroma and taste due to broiling. Steam of very high pressure from circulated water has been used for this purpose, but economical questions in connection with the distribution have prevented the extension of the system.

In any building all the work that could have been done with steam generated on the premises can be performed with transmitted steam. If desirable, a steam engine and dynamo may be operated to generate electric light, and the steam may be used directly through steam engines, or through steam pumps and hydraulic apparatus, or through the electric apparatus, to operate elevators. Moreover, steam power is available at all times to maintain water under pressure in all parts of a high building. The premises can be thoroughly heated, and, if the power be sufficient, exhaust steam can be used for heating with great economy. The exhaust steam contains fully ninety per cent. of its heating value, after losing nearly all its pressure to do the work, though retaining sufficient to produce a circulation in the distributing pipes and radiators throughout the building. By the use of a vacuum pump at the tail of the system, the pressure required for circulation may be kept so low that the back pressure will not reduce appreciably the economy of the engines. The heat, moreover, is much more pleasant, as the lower temperature in the radiators does not "burn the air," as it is expressed, or, more correctly speaking, does

not scorch, at least to such an extent, the dust and impurities floating in the air. It may be said that all the advantages due to the use of steam in a building may be obtained by generating the steam on the premises, but, with distributed steam the nuisance of handling coal and ashes is overcome, the heat from the boilers in the basement is removed, and the fire risks are greatly reduced. The steam supplied is, moreover, available day and night without maintaining a force of firemen as well as engineers for the purpose.

The desirability of using steam distributed from a central station, in all cases where it is available, is evident, but experience with the large modern buildings in New York shows that the adoption of the system in such buildings turns principally on the question of relative expense. In some of these buildings several hundred horse power are required, and the plant is of sufficient size to generate the steam almost as economically as it can be produced at a central station. The owners of the district steam system must necessarily pay the interest on the cost of the real estate with the necessary buildings, boilers, and main pipes through the streets to distribute the steam, maintain all these structures, and, in addition, make a profit on the investment; and the augmentation of the actual cost necessary to accomplish this is greater than the slight increase in the cost of coal and operating expenses in the large buildings, due to the maintenance of smaller boiler plants on the premises. The new buildings are extended well underground, so that the high cellars furnish ample room for boilers and the remainder of the steam plant, without injuring the remainder of the building, and in most cases basements are arranged above the cellars, which have important rental value. The distributed steam was introduced in several of these buildings, but was finally displaced for economical reasons.

The distributed steam has, however, been a great boon to smaller buildings, where boilers of proper size either could not be introduced at all, or would so concentrate the heat as to decrease the rental value of the rooms above. In some cases also the expense of an additional man as fireman would be so large a proportion of the total expense as to warrant paying the price charged for the distributed steam. In any event, the distributed steam has been largely introduced in buildings of moderate size, and with it all conveniences of the larger buildings, such as quick-running elevators, steam heat in winter, cold water, and in some cases hot water, on all the floors, etc., so that the owners are enabled to compete for tenants satisfactorily.

The distributed steam has also had a large sale in small manufactories distributed through the district. In such buildings a steam pipe is run in from the street and carried up either from the basement

vertically, by the indulgence of the lower tenants, or by supporting it over the stairways, the power being thus introduced to any floor desired, transforming into hives of industry the upper stories of old warehouses scarcely rentable at all under previous conditions.

District steam plants have also proved desirable in residence districts. This is true both in the large cities and those smaller ones where the better residences are practically in the suburbs and surrounded by extensive grounds. In a residence district in a city it may not pay in the summer to keep the plant in operation merely to supply steam for some portion of the cooking in the houses and to maintain the elevator, lighting, and cooking service in the hotels and apartment-houses in the vicinity, but it appears to be a necessity, to be offset by higher prices in winter, the comfort and convenience of the system being sufficient to secure satisfactory patronage. No such question arises in regard to the use of distributed steam in the smaller cities. The plants are made for low pressure, constructed as cheaply as possible, and operated only during the heating season. There are several such plants in cities closely accessible to the coal regions. This gives an advantage to the owners of the plant in securing slack coal at a little more than the cost of haulage, whereas the owners of the dwellings formerly used large and expensive coal for their furnaces. The distributed steam, is, moreover, continuously available, and gives better and more satisfactory service, so that the difference of cost to the owners, if any, does not prevent a generous patronage.

In some cases steam plants have been constructed by the gas companies, the arrangement furnishing a ready market for their coke under the old system of making gas, and the concentration of more business in a single station promoting economy. Some gas companies have also gone into the electric-lighting business to concentrate as much of the municipal business as possible in their own hands and keep out competition.

Some business has also been done in distributing exhaust steam from large electric-lighting stations to buildings in the vicinity. One method of utilizing the exhaust steam, first developed by the writer, is to heat water with the same, and distribute the hot water with pumps, to heat the various buildings.

The influence of the more general distribution of electrical energy on the question of distributed steam for power needs careful consideration. The capital account of the electric plants in the United States is very large; the original cost was considerable and over-capitalized, and rebuilding, which has been necessary in most plants, required increased capitalization, so that it has been impossible to furnish the electric current at prices which would be considered reasonable for

considerable powers. A more liberal policy has recently prevailed, by which current is sold for power at lower prices than for light, and the prices decrease as the quantity of current to single consumers is increased. This has greatly promoted the sale of electric power and operates much as did the distributed steam, originally, to build up small industries. Evidently the electric conductors can be brought into buildings at very much less expense than steam pipes, and, from the absence of heat and waste, the electric motor is more desirable in mild weather than a steam engine. For very small powers, or those used intermittently, the price of the electric current can be high, for the reason that, being supplied by meter, no charge is made when the current is not used, and there is no loss when the motor is not in operation. An elevator in an apartment-house is a good example of intermittent use. When steam is used, condensation is continuously going on, which, though not serious if the pipes are properly protected and operated nearly to capacity, is certainly a disadvantage for intermittent powers. In New York up to the present time the Steam Company has held its power-consumers, and the electric companies have built up their business in other districts. As the matter stands, apparently new industries secure the power available in the particular district. In making new installations the conditions at the particular place need to be considered.

For the future construction of a district steam system, a close study of the conditions must be made in each case. The subject may be considered in relation to two kinds of plants,—*viz.*, high-pressure plants for both power and heating, and low-pressure plants for heating only. In view of the local competition possible in large office buildings and the availability of electricity, from lighting plants for small powers, it is probable that it would rarely pay, under the conditions obtaining in the United States, to build a high-pressure district system for both power and heating in large cities with a temperate climate. Exceptions should be made where owners of property, in a special district, combine to build a central plant which will start business with a large and established market.

In colder countries, where the necessity for heat extends through a larger portion of the year, and in large European cities, where the insurance is greatly increased by the use of steam boilers in a building, the district system can be adopted with decided advantage, and, in general, a high-pressure system is required. It is advantageous to further extend the distribution of exhaust steam for heating from large stations for generating electricity, etc., and considerable business may also be done in building low-pressure steam plants for use in winter in residence districts, both in large and small cities.

An ideal arrangement for closely-built portions of large cities would be, for the poorer districts, to simply distribute steam and gas, in addition to water, the steam at high pressure so as to encourage small manufactories and operate elevators. Then all the buildings could be heated by steam, and the greater part of the cooking could be done by it, and the gas could be used for lighting and a few culinary operations requiring a higher temperature than that furnished by steam. For the middle and richer classes, in addition to water, low-pressure steam, gas, and electricity should be distributed, the steam to be used for heating and boiling, the electricity for light as required, and the gas for light and culinary operations requiring a high temperature. Thus it would be possible to carry on all the varied operations of life satisfactorily without the direct consumption of a pound of coal in any building.

The writer was called upon in the autumn of 1869 to investigate what had been done with district steam systems, and design one adapted to carry steam of sufficient pressure for power in the city of New York. Steam had already been satisfactorily conveyed considerable distances. The early attempts involved lateral flexure of the pipes. This had been prevented by Holly by anchoring slip joints, but, though he had built many plants, the pipes were drained to each consumer, and the system was in many respects not adapted for power. It was concluded that a system of stuffing boxes with manholes would, in a city, be a continual annoyance which might render the system impracticable. The writer therefore experimented with diaphragm joints, obtaining greater and greater satisfaction as the thickness of the diaphragms was reduced, until finally they were made of corrugated copper less than $\frac{1}{16}$ of an inch thick and supported upon radial bridge plates which prevented the copper from collapsing. This made the expansion joint absolutely tight, and, by moving sample diaphragms under pressure back and forth a sufficient number of times to represent the probable expansion and contraction for several hundred years, it was proved to be reliable for an indefinite period. This system of expansion joint, or "variator," as it came to be dubbed, was employed in all the work of the New York Steam Company in New York city, and has proved satisfactory in every respect. In the original construction a smaller pipe with similar details (since abandoned, as explained hereafter) was laid alongside the other, to carry the water of condensation back to the station.

On account of the great value of land in the lower part of the city, the boilers were arranged in the station in four tiers in as many different stories, with a high story above for coal-storage. In general, buckwheat coal was employed, which would run in chutes down

between the boilers, so as to require little shovelling, and, alternately between the boilers, ash chutes were arranged, connecting with the pans under the furnaces, so that, as the fires were cleaned, the ashes ran to the cellar and were there withdrawn in cars, lifted by an elevator to the roof of a rear building, and shot into carts to be carted away. Coal was brought from the docks, and dumped to similar cars in the basement, which were carried up and run out and dumped into the coal-bin in the top of the building. The first station was designed for sixty-four Babcock & Wilcox boilers of 250 h. p. each,—a total of 16,000 h. p. The station was not carried to the full height in the first place, but by 1887 three stories of boilers, or three-quarters the proposed power, had been put in, which, when forced in winter, gave as much power as was intended for the whole station. This station is probably as yet the largest boiler plant in the world, though some of the sugar refineries have plants of nearly the same size. Two of the ocean steamers have developed 30,000 h. p., but this is in compound engines, so that the boilers are really of less power than those of the steam plant.

Many details of a novel character were necessarily devised in carrying out this enormous enterprise, but it will not be possible to refer to them in this article. Among other things a practicable steam meter was devised, and one was placed on the premises of every consumer.

The installation of this plant was not without its difficulties. An opposition company secured a charter, and commenced work in an adjoining district without fully understanding the business. Their pipes were laid on the theory that, by superheating the steam, no condensation would take place, and that it would not be necessary to grade and drain the pipes. The consequence was that, when steam was turned on, it did condense, water collected in the low places, and, when a demand was made for steam beyond this, water mixed with the live steam from the boilers, causing water rams, and the pipes were continually exploding, no less than five explosions occurring at one place. The mechanical construction, too, was bad. Finally, from the accumulation of difficulties, the company succumbed, but its operations greatly embarrassed those of the New York Steam Company, which had no such difficulties with its work. The work of the latter company had, however, been carried on under embarrassments. Notwithstanding the protests of the engineer, the men were privately hurried, so as to reduce the expense, and some bad work resulted which would have been inexcusable under other conditions, and which had to be remedied at great cost. In due time a new difficulty occurred, of the highest interest as showing that no care can

provide for every condition. The return pipes began corroding on the exterior, while steam pipes in the same trench, and occasionally in the same conduit, were in no way injured. The rapid corrosion of return pipes was, of course, known, but the writer, in common with others, attributed it to their location in damp cellars, etc. There was no dampness in these trenches alongside the steam pipes, and it was finally determined that the corrosion was caused simply by the fact that the carbonic acid in the atmosphere and soil acts with the greatest virulence at or about the temperature of the water in the return pipes, or a little above the point of boiling water in the open air, the higher temperature of the steam pipes being sufficient to prevent this action. It therefore became necessary, in due time, to abandon the return pipes, and the various drips, through cooling coils in the building, were discharged directly into the sewers, thus keeping the pipes drained as before. The saving due to returning the water of condensation is about one per cent. for each ten degrees that the feed-water entering the boiler is heated, or, for one hundred degrees, about ten per cent.,—sufficient to pay a handsome dividend on the enterprise. It is therefore desirable to use return pipes in building such a plant, unless exhaust steam is available for heating the water; but such return pipes must be made either of brass or of cast-iron, so as to entirely prevent oxidation, or at least make it so slow as to be of no consequence.

THE ESTHETIC TREATMENT OF ENGINEERING WORK.*

By H. Heathcote Statham.

WITH regard to the vast majority of engineering works carried out in the present day the subject of this paper might be susceptible of treatment as brief as the celebrated chapter "Concerning Owls" in a natural history of Ireland, which merely ran: "There are in Ireland no owls of any kind whatever." So we might say at once: "There are in modern engineering no esthetics of any kind whatever"; engineers in general merely considering how to obtain the required strength with the least expenditure of material and at the lowest cost. It may be replied that engineers are not such heathens; that they introduce columns, capitals, classic orders, carving, etc., into their stone or granite piers or on the fronts of railway stations; that they are known to insert wriggly ornamental work in cast iron in the spandrils of an iron roof-principal, and that they place Corinthian capitals with cast-iron foliage round the tops of the iron columns in railway stations; and, as none of these things are of any practical use, their purpose must be esthetic. But this is exactly one of the points I am about to traverse. Αἴσθησις, from which we derive "esthetic," signifies perception, in its simplest meaning; and in its derivative and wider meaning intellectual perception as to form and fitness of execution. But there is not much intellectual perception in clapping upon a work some kind of architectural detail which in no way belongs to the construction or has any suitability in connection with it, merely because it is supposed that the public expect to see something ornamented there.

Architects do this to a considerable extent, no doubt; but at the worst they do it with a certain perception as to suitability of expression. In fact, the object of an architect (whether he succeeds in it or not) is to produce a structure which shall be pleasing to the eye and to the sense of taste,—a matter about which the engineer cares not a button. So long as the structure performs its practical function, an engineer not only does not care how ugly it is, but rather boasts

* Mr. Statham handles his subject without gloves, as is fitting in an essay addressed to intelligent engineers, with whom the question will always be, *not* "is it pleasant?" but "is it true?"

The matter of suitability, composure, and grace of design is even more important in mechanical work than in the larger constructions of the civil engineer, to which Mr.

of his indifference on that score. In fact, he does not understand why you call it ugly. And this is the point on which architects may certainly claim to have a distinct advantage over engineers. Although there is much special constructional work done by engineers the details of which are not familiar to architects, there is nothing in the constructional work of engineering which an architect cannot fully understand and appreciate. But there is a good deal in architectural design which engineers seem quite unable to perceive the value of, and this in relation not only to modern architecture but to works of the great period of building. I have stood with two engineers in one of the best bits of thirteenth-century interior architecture in England, and been asked by them: "What is it that you admire in this?" the question not being put in the way of a sarcasm, but, like Miss Dartle's questions, "for information," which, of course, I was unable to impart; it was a question of perception, not of information. In short, architects understand engineering a great deal better than engineers understand architecture.

The main reason for this probably is that an engineer's esthetic perceptions are absolutely atrophied for want of exercise and training. The whole of his professional education, which in most cases begins in a foundry or an engine-building yard, is directed solely to the consideration of practical construction, of the way things are put together, not the way they look. He is never encouraged to think about what is called the "design" of a piece of work; he does not clearly realize what design means, and he lives and works among people who do not. But, as he gets into practice and has to carry out such works as railway stations, railway viaducts, etc., on a large scale, a vague persuasion comes over him that these things are expected to be "handsome;" other works of a similar kind, he sees, are thus made handsome; ornaments are stuck on them; pilasters, finials of various kinds, big scrolls of foliage, etc., the contemplation of which seems to arouse the reflection, "go thou and do likewise," or even "handsomer." The *raison d'être* of the matter, the relation of the ornament to the construction, is not considered at all. A local borough engineer, an excellent and

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Statham more particularly addresses his criticism, because it is more directly convertible into a money equivalent. Instances of a bridge design standing or falling on esthetic merits are, perhaps unfortunately, rare; but the machine-tool will often find acceptance or rejection as its appearance is pleasing or the reverse. Nowhere will useless ornament be more utterly condemned, but nowhere will the merits of fine design and artistic workmanship be more quickly and more practically recognized. The salesman can readily dispose of a handsome tool, remembering that one great element of beauty is adaptation to intended purpose; an awkward or unsightly machine stands already half condemned in the eyes of the prospective user. For this reason it is especially desirable that modern machine-designers should study the principles of design, and profit by the authoritative and searching criticism that Mr. Statham offers.—EDITOR.

most competent man in that capacity, brought me one day four designs he had made for a stone bridge over a roadway in his district, which it was proposed to pull down and rebuild (I believe much more because it was old-fashioned than for any practical reason). That he should have thought an architectural opinion worth having on the point was an indication that he desired at least to do the best he could in regard to the appearance of the new bridge; that he should have asked my own opinion in particular was a compliment which I fully appreciated. But the case was hopeless; all the designs were covered more or less with bad architectural (?) detail, having no relation to the construction; all I could do was to recommend the adoption of the plainest design of the four, on the principle that, as all the detail was bad, the less there was of it the better. "But why do you select the very plainest of the four?" quoth the engineer.

That is just one of the points that one cannot get the modern engineer to understand. A piece of bold scientific construction, especially on a large scale, is a great deal more effective, more interesting, even more picturesque, if left to itself, than if concealed or be-devilled with bad ornament. I remember an illustration in an American engineering paper (I forget which) of a large railway viaduct carried across a valley (I forget where), consisting only of plain lattice-girders laid across the tops of a succession of massive truncated pyramids of rough coursed masonry, without any attempt at ornament or architectural detail of any kind. But the massiveness and simplicity of the thing made it picturesque, and one could not help thinking that, if engineers would be more often content to let well alone in this way, and trust to the inherent impressiveness of simple structure, they often would receive blessings from the esthetic mind, instead of something quite the reverse. To instance a case more in detail: There is a large iron roof in London, of very scientific structure, one very wide center span and a narrow aisle (to borrow an architectural term) on each side. The horizontal girders over the "aisles" form an abutment to the arched girder of the center span, and the outer ends of the "aisle" girders and the springing of the center girder are carried on a column under each principal. These columns are made slightly fish-shaped, swelling in the center of their height and tapering to top and bottom, both ends being rounded and working in a cup at top and bottom, so as to be free to move with the expansion and contraction of the center span. The effect, where the roof had just been set up, was not only most workmanlike, but really graceful. In a corner of the ground I came on a whole heap of cast-iron Corinthian capitals; what were these for? It appeared they were to be fitted round the tops of the columns to conceal the real construc-

tion, and to show a capital where a capital was generally found. "Why!" I said to the engineer, "you have done a first-rate thing, and now you are going to spoil it with this gewgaw." He saw the point well enough, but his defence was that the public were so accustomed to see a capital at the top of a column that without it they would think the structure unsafe! There are many engineers, however, who would not even have recognized that there was any reason in the criticism. As to the public, they never look at an iron roof, or consider whether it is safe or not; they accept that in faith. But, if they do expect to see a useless cast capital round the top of an iron column, it is the engineers who have taught them the lesson. Why not unteach it?

The greatest engineering structure of modern times, the Forth bridge, is an example of simplicity of treatment, not perhaps so much on principle as because the vast scale of the work put anything like ornamental treatment out of the question, which was probably the better for the total effect. The Forth bridge is, in fact, a colossal trestle bridge, with no more pretence to architectural design than a builder's timber scaffold, which, it may be observed, is often a rather picturesque object. The bridge has something of the same kind of picturesqueness, together with the impressiveness arising from its enormous scale. Yet, though we certainly do not want it ornamented, something might have been done which has not been done. The Forth bridge is, in fact, a rather typical example of one of the common faults of engineering design,—*viz.*, the ugliness and artistic clumsiness of the manner in which connections are made. It seems to be considered enough to rivet one piece up to another in whatever way may be the strongest (or strong enough) for its purpose, without any attempt at shaping the connecting parts or forming a harmonious line. This is constantly to be seen on a smaller scale in such things as the connections of strutts or tension bars with main ribs in roof girders. There is not the slightest attempt to shape the working portions. Without any ornament at all, some attempt at shaping would make all the difference in the general aspect of work of this kind. That is one of the great differences between medieval and modern metal work; the medieval workman always had that *shaping* instinct, and never left his junctions awkward and clumsy in appearance. Of course his iron work was on a much smaller scale; but the principle is the same in large as in small work, and in most iron work on a large scale it could be applied if there were the desire for it; its neglect is the result of sheer indifference. The enormous scale of the Forth bridge may put it in a special category in this respect; but still even here something better might have been achieved. Standing on one

of the piers, for instance, one sees the base or foot of the great curved member of the cantilever looking as if the whole weight and thrust of that member were taken by the mere edge of a steel plate; it is not really so, of course, but it has that appearance, and nothing could look worse. It is characteristic, too, of the spirit of modern engineering that the curved member, to save trouble in fitting, was not made a true curve, but a succession of short straight tubes, each fitted at a slight angle to its predecessor. The bad effect is not so very obvious on a side view of the whole elevation, but it is very obvious on an oblique view, when the cantilever is seen foreshortened; it is noticeable even in a comparatively small photograph, and gives a strangely coarse and crippled effect to the appearance of the whole. It is impossible to suppose that the manufacture of a true curve would have presented any real difficulty, but it would have been rather more expensive to carry out, and, for the sake of that, the appearance of the structure has been consideraby injured. The whole subject is one which engineers ought to take into consideration; it is really a question of the most perfect and workmanlike manner of doing a thing. "Art," said Mill, "is the endeavor after perfection of execution"; and, though that is an imperfect definition and will not include all the aims of art, it includes the main part of what goes to make a plain structure a work of art. It is a question of joining two parts not merely in the strongest manner, but in the *best* manner; and the best manner means that which combines neatness and finish of line and appearance with strength. This may seem a small thing in itself, but greater attention to it would make an immense difference in the artistic effect of engineering works.

Another weakness in engineering works in iron and steel is their terminations; terminals is perhaps the proper word. In the case of such objects, for instance, as built-up steel towers or standards for taking the chains of a suspension bridge, engineers in general seem to have an idea that these erections cannot be considered complete without the most extraordinary and preposterous finials being formed on them,—things which remind one of the old-fashioned forms of decanter-stopper, greatly magnified in scale and exaggerated in character. It is impossible to imagine why engineers put details of this kind on their works; they are nearly always hideous in outline and character and in the most tawdry and vulgar taste. This is another instance of the bad results that are obtained because engineers cannot be content to leave well alone. We presume they must imagine that these decanter finials are an ornament; but the real fact is that, if they put nothing at all, the effect, in the eye of any artist, would be infinitely preferable.

In regard to masonry structures it is worth notice that, as late as the beginning of the present century, English engineers could turn out really grand works, such as London bridge and Waterloo bridge. The contrast between these works and the gewgaw style of many of our modern bridges is again an example of the importance of reticence and dignity of design, and of the sad results produced by the fancied necessity for covering engineering works with bad and misapplied architectural detail. Look at London bridge, a really grand work, but which is so mainly from the fine line of its arches and the plain, massive treatment of the whole. Except the plain modillions under the cornice, there is not an architectural feature, in the usual sense of the term, in it. Compare this with Blackfriars bridge, with its great polished granite columns on the piers, looking adequate to carry a tower, and carrying in reality nothing but the small balcony-like projection over the pier; look at the coarse, tawdry carved ornament of the capitals of these columns, and realize what a fall this is from the simple and unpretending dignity of London bridge. The last Thames bridge, the Tower bridge, is even worse; it is the most terrible and monstrous piece of sham ever erected. The masonry towers, considered *per se*, are very poor concerns,—tawdry Gothic, totally deficient in breadth of style or power of effect,—but they become simply contemptible when we know that they are only masonry skins carrying nothing, and, in fact, supported by the steel work which they conceal. To make the farce complete, the heavy suspension chains of the side spans of the bridge are led up through "hawse-holes" into the masonry, so as to keep up the pretence that the towers are supporting the chains, which would, in fact, pull them down immediately. This is one of the cases in which one feels that the naked exhibition of the steel structure, with no pretence at architectural treatment of any kind, would have been infinitely preferable to this foolish piece of elaborately-constructed scenery.

Another of the points in which the modern engineer is so woefully at sea when attempting what he supposes to be an ornamental treatment of his structure is the scale of the details. The engineering idea seems to be that in making mouldings and ornaments for a big work it is simply necessary to magnify everything in proportion; to have great lumps of mouldings, imitations of those which are commonly used on a smaller scale, and enormous carved or cast ornamental foliage and other such horrors. Instead of increasing the sense of scale in the structure, that is just the way to decrease it. One of the most extraordinary instances of this is to be found in the present Hammersmith bridge over the Thames, designed by the late engineer to the London county council,—a structure which, in fact, is almost an

epitome of all the faults of the day in regard to engineering design. It is an iron suspension bridge, with towers apparently designed to imitate stone ones, with portentous finials; and at each end, at the shore approaches, the side of the bridge is decorated by an enormous piece of classical-looking acanthus scroll in cast iron, about fifteen feet long. When giving a lecture on the bridges of London to the London Architectural Association, a little while since, which was illustrated by lantern views, I had secured a good end view of one of these wonderful pieces of detail, and, if any engineers had heard the roar of laughter with which its appearance on the screen was greeted, they might perhaps have become convinced that there must be something radically wrong in their way of doing things.

The fact is that engineers evidently do not believe that there is any such thing as an art of design at all. They think that, if they want to make a thing "handsome," all they have got to do is to clap upon it some of the features which they are accustomed to recognize as architectural embellishments, such as pilasters, and carved capitals, and spikes and spirelets and finials, making them much bigger and coarser to suit the scale of the work, and the thing is done. What engineers require to learn is that design is an art not to be appreciated and understoood without systematic study and training of the mind to that end; and that, in attempting to handle it without that kind of training, they are merely cumbering the ground with absurdities and making themselves a laughing-stock. If they reply that the study of the practical problems of their profession leaves them no time for the study of design, there are two courses open to them,—either to engage an architect to work with them as far as the design is concerned, or to make up their minds to leave design, in the higher sense, alone, and to be content to construct merely, and to leave their constructions in severe simplicity. There are cases in which this latter is on every ground the best course to pursue. The structural elements of a suspension bridge, for instance, are so charming in themselves that no "treatment" can improve such a structure, and the more simply it is treated the more pleasing it will look. There are many other cases in which, as in the instance of the American railway viaduct already referred to, a perfectly simple and unadorned treatment may be picturesque, and will at all events be inoffensive. The worst offences against taste in modern engineering structures come from the wish to do something showy. Apart from this, the weakest point in engineering works is the bad and clumsy designing of junctions and connections. An improvement in this one respect would make a great difference in the attitude of the architectural mind towards the work of the engineer.

ERICSSON'S FIRST MONITOR AND THE LATER TURRET SHIPS.

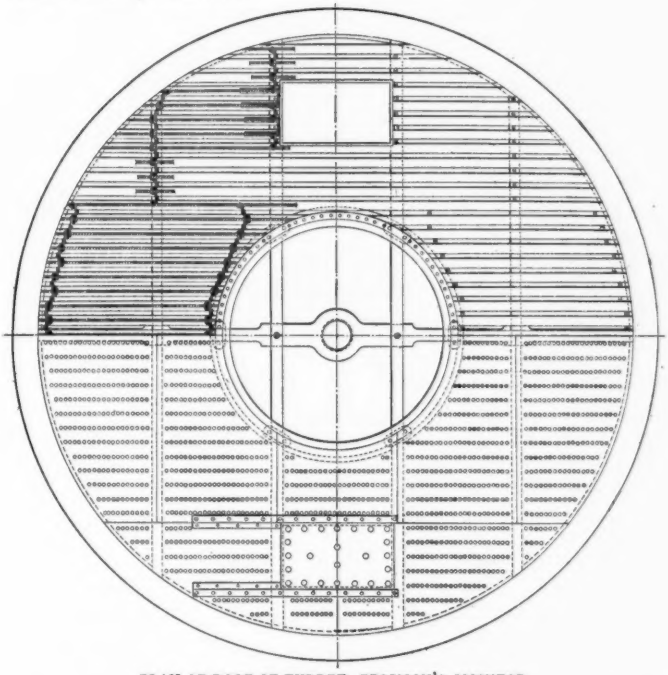
By George L. Fowler.

DURING the decade from 1850 to 1860 the maritime nations of Europe came to a partial realization of the fact that wooden walls had ceased to be an effective protection against the artillery of an enemy, and the tentative construction of iron-clads was begun in England and France. In 1854, during the war of the Crimea, Captain John Ericsson, desiring to assist in striking a blow at Russia, the hereditary enemy of his native country, Sweden, offered to the Emperor Napoleon the plans of a vessel of peculiar construction, and one so designed as to be invulnerable to any artillery that the Russians possessed. It was a turreted vessel, but, after examining the plans, the emperor sent word to the inventor that, while greatly interested in the design, he thought that the small number of guns which could be mounted would render the vessel incapable of holding its own with those against which it would be pitted, and declined to build one as an experiment.

The plans were, therefore, laid aside, and nothing was done with them until after the breaking out of the civil war in the United States. In the fall of 1861 the Confederate forces, in possession of the navy yard at Norfolk, Va., raised the old frigate Merrimac and converted her into a most formidable fighting machine. Mr. Mallory, who was the secretary of the navy for the Confederate States, seemed to have realized that a single powerful iron-clad would prove more serviceable than any number of men-of-war of the ordinary type in raising the blockade of the southern ports, and it was in accordance with this idea that the Merrimac was reconstructed. Her engines were wholly unfitted for the work put upon them, and were incapable of giving the vessel much more than bare steerage way, yet, defective as the vessel was, the moral and physical efficiency was enough to raise the hopes of the south to the highest pitch of jubilation and throw the north into a state bordering on panic, culminating in the destruction of the Cumberland and Congress.

Meantime Ericsson had presented his plans of a "fort upon a raft" to the navy department to have them declined; then by a special commission they were voted against, and it was only by a trick on the part of one of his friends that the inventor was induced to appear personally before the board and succeeded in persuading them

that the plan would be a success. He agreed to build the Monitor in one hundred days, at his own risk, and to refund all moneys paid on account if the vessel failed to sustain the fire from the enemy's batteries. The navy department kept up a constant nagging during the whole period of construction, urging him to speed, casting continual doubt on the successful outcome of the experiment, and hampering the contractors by withholding the payments on account, while the press dubbed the vessel "Ericsson's Folly," and complained of the waste of money involved.

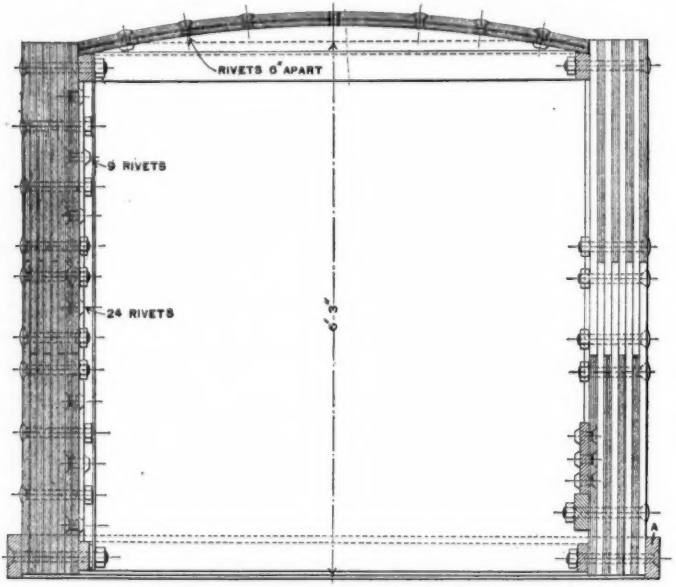


PLAN OF ROOF OF TURRET, ERICSSON'S MONITOR.

Then came the meeting of the giants. Each represented a type that was fighting not only for the causes which it represented, but for its own existence as the fittest to survive and be the prototype of the future fighting machines of the navies of the world. We all know that the Monitor with its revolving turret was the victor, though at the time both sides claimed to have had the better of the fight, and subsequent opinions are united that the new turret ship was

unskilfully, though bravely, fought, as would have been expected from men just over a very trying sea voyage and in a ship fitted with new and untried machinery. But, whether the day belonged to the Monitor or not, certain it is that the ultimate victory belonged to the turret type.

The Monitor may be described as a raft with a hull or air chamber beneath to give the necessary buoyancy to carry the fort that is placed above. The hull was entirely protected by the upper works, with which we are chiefly interested. The raft or platform was 174 ft. long, 41 ft. 4 in. wide, and 5 ft. deep, while the hull beneath had a length



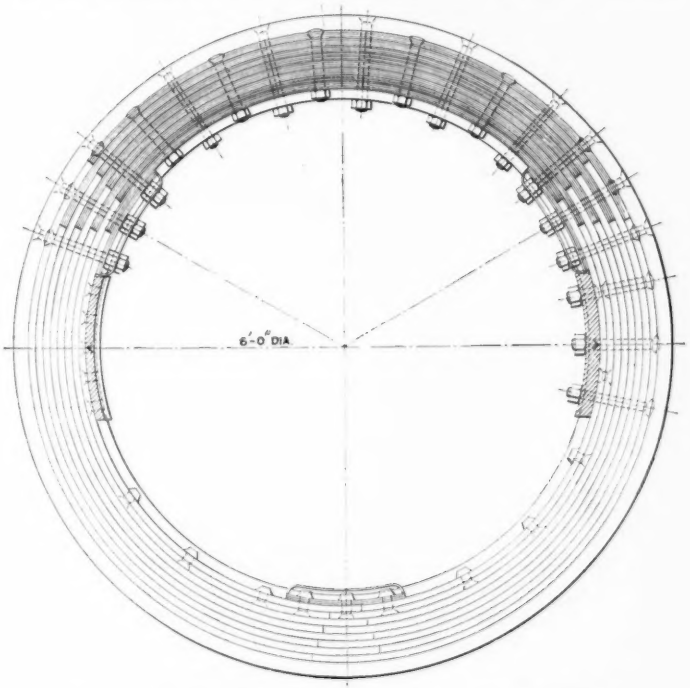
VERTICAL SECTION OF BUILT-UP TURRET, ERICSSON'S MONITOR.

of but 124 ft. and a beam of 34 ft., thus giving an overhang at the water edge of 25 ft. at each end and 3 ft. 7 in. at the sides. The sides of the platform were perpendicular; and were built of white oak for a thickness of 2 ft. 6 in. protected by iron armor plating 6 in. thick.

Upon this deck the cylindrical turret was placed. This had an internal diameter of 20 ft., and was 9 ft. high. There were two port holes 6 ft. above the deck for the guns on the same side, and these

guns were 11-in. columbiads firing a shot weighing 184 lbs. and using 15 lbs. of powder. These guns were mounted on carriages moving in slides of forged iron that extended all the way across the turret.

The turret was composed of concentric rings of 1-in. iron set vertically and firmly bolted and riveted together, but having no horizontal joints, and presenting a thickness upon the fighting side of 11 in. and of 9 in. on the opposite. The plates overlapped or broke joints so that only a single joint was presented at any one place, and



HORIZONTAL SECTION OF BUILT-UP PILOT HOUSE, ERICSSON'S MONITOR.

they were put together after the manner shown in the engraving of the pilot house. The roof was formed of forged beams covered with perforated plate iron, and was braced on the lower surface against the sides of the cylinder. There were two sliding hatches in this roof, by which access was gained to the interior of the turret.

The weight was sustained by a vertical shaft 10 in. in diameter

that rested in a cup supported by a bracket firmly bolted and braced to the main bulkhead of the vessel about half way down. The machinery for turning the turret consisted of a double-cylinder engine driving a pinion that meshed in with a spur wheel of 6½ ft. diameter and 11-in. face fixed to the shaft that carried the weight. The circumference of the turret rested upon a turned composition ring set into the deck,—an arrangement that was soon changed in subsequent vessels for supporting rollers.

While the turret was capable of delivering an all-around fire, the actual working of the vessel was somewhat handicapped by the fact that the pilot house obstructed the direct fire forward and the smoke-stack that aft,—a condition that was removed in the later vessels of the "Monitor" type by placing the pilot house or conning tower on the roof of the turret and lowering the smoke-stack.

The engravings of the section and plans of the pilot house show the methods of construction of it and the turret. At that time there were no mills capable of making the thick plates now in use, and the system of bolting and riveting shown was used. The base of the pilot house was strengthened by the ring A, which was turned all over and carefully fitted in position.

The success of this private vessel was such that it was immediately followed by the construction of several others, while some iron-clads of the "Merrimac" type were built for service on the western rivers.

Abroad the influence of the new type was instantaneous, though actual construction was somewhat tardy of realization. A sort of inverted revolving basin had been suggested to the English admiralty a year or so before, and had been rejected; but the battle of the Monitor and Merrimac in Hampton Roads caused the scheme to be revived, and the Royal Sovereign was converted into a turret ship. This vessel was originally a three-decker, and was cut down and plated with iron armor 5½ in. thick, and fitted with four turrets, having two guns in the one forward and one in each of the others. In order to obtain more freeboard at sea, light iron bulwarks 3 ft. 6 in. high were hinged along the sides, and were to be turned down when it became necessary to fight the guns. The turrets, instead of revolving on a central pivot, as in the case of the Monitor, were supported and rotated upon rollers,—a construction that has been followed ever since.

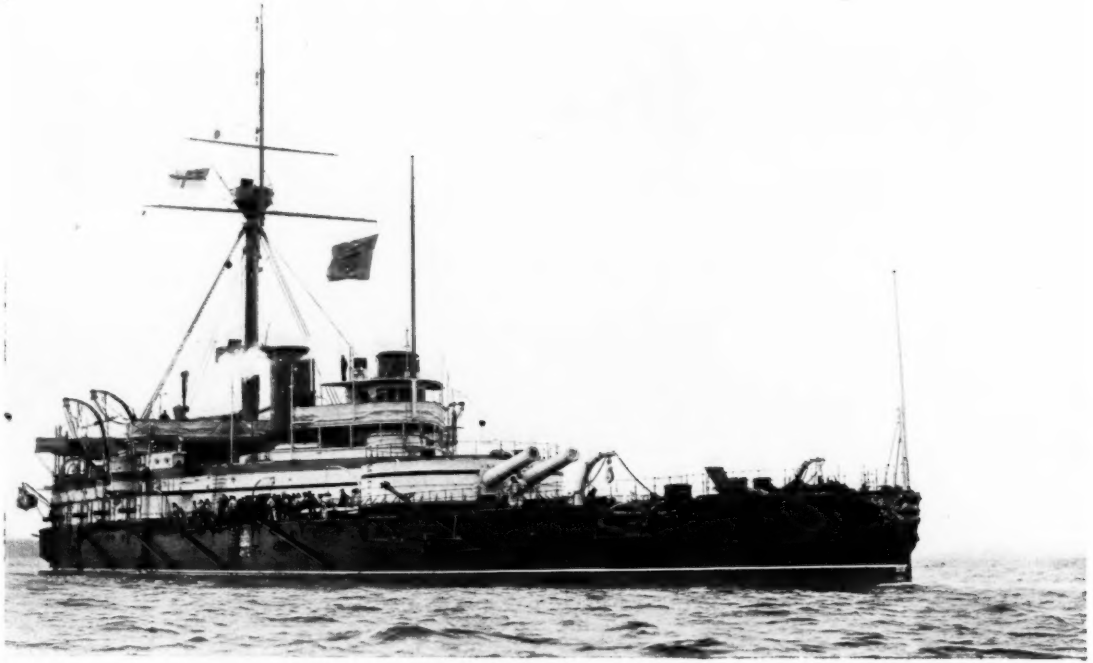
Although the orders for the conversion of the Royal Sovereign were given in 1861, it was not until 1864 that it was completed. H. M. S. Devastation was the first seagoing mastless ship to be constructed; for, though the Monitor did go to sea, it was intended only for harbor operations, and the original contract required that

H. M. S. DEVASTATION—A TYPICAL TURRET SHIP.

she should be fitted with masts and sails. The characteristic features of the Devastation were the low freeboard and the two turrets on the center line of the hull. In order to protect the base of the turrets, they were enclosed in an armored breastwork, or citadel, which did not, however, extend across the vessel, a space being left between it and the ship's side. The armor extend edall of the way around, and was 12 in. thick amidships, tapering to 10 in. at the bow and stern, while that of the turrets is 14 in. The Devastation carries two 35-ton guns in each turret. Though the general opinion of the navies of the world has inclined toward the double turret, especially in vessels of large dimensions, yet in two later iron-clads, the ill-fated Victoria and the Sanspareil of 10,500 tons, there was a single turret forward protected by 18 in. of compound armor, and carrying two 110-ton guns. In order to compensate for the loss of stern fire entailed by a single forward turret, these vessels were armed with a 29-ton gun mounted aft behind a barbette shield.

In the Benbow of 10,600 tons a 110-ton gun is mounted upon each side in a pear-shaped barbette 60 ft. long and 45 ft. wide protected by steel-faced armor 14 in. thick.

The Magnificent also mounts her heavy guns, four 12-in. breech-



A TURRET SHIP—H. M. S. VICTORIA.

A BARBETTE SHIP—CAMPERDOWN.

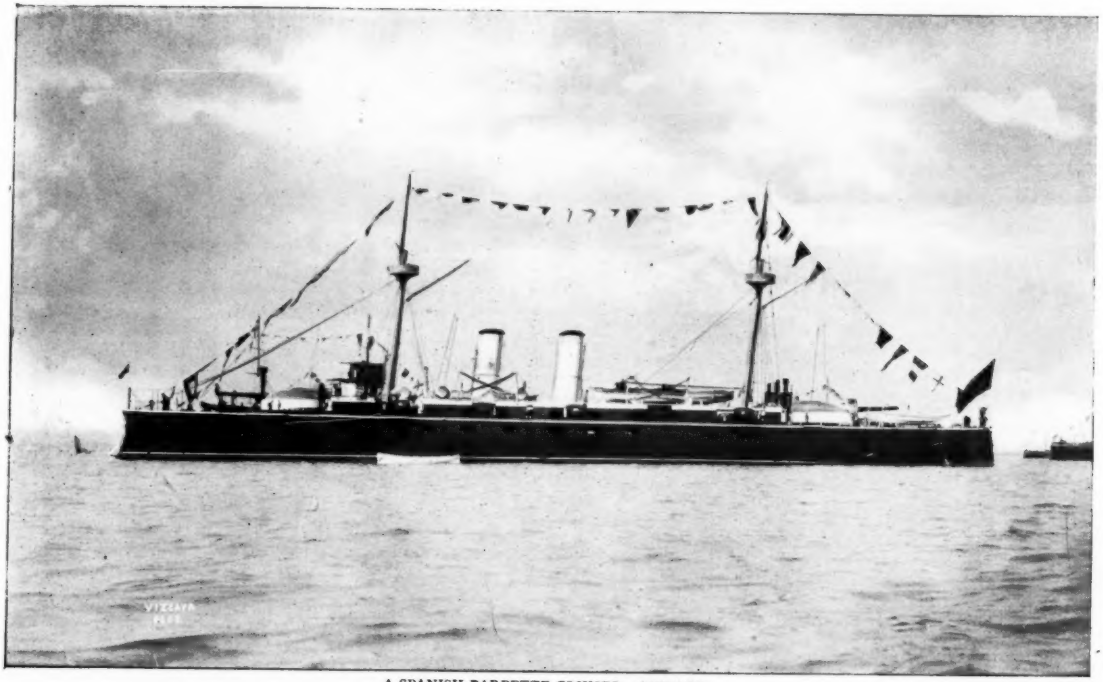
H. M. S. BENBOW.
Showing heavy guns mounted in barbette.

H. M. S. MAGNIFICENT. TYPE OF AN IMPORTANT CLASS IN THE BRITISH NAVY.

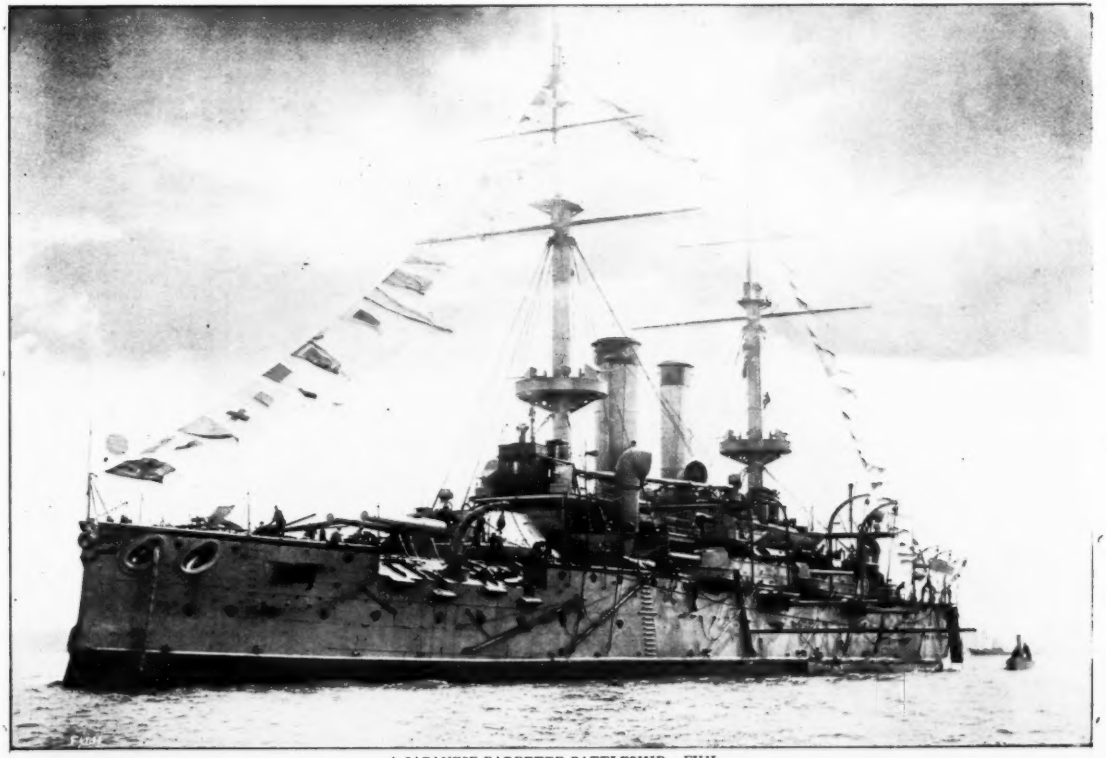
loaders, in two strong barbettes. These guns can be loaded in any position, and are protected by a strong armored shield mounted on the turn-table and moving with the guns.

This development of the turret and barbette in the English navy was naturally imitated by the other nations of the world, who followed in the footsteps of the great sea-power, even when their vessels were built at home. Thus Spain in the Maria Teresa and Viscaya built on English plans, though constructing the vessels in her own yards. They have a flush upper deck without bulwarks, and a breastwork within which the 6-in. quick-firing guns are mounted. Within the extremities of the belts are the two barbettes, one at each end, and these are built of compound armor 10 in. thick. The barbettes are of circular section, and stand about 6 ft. above the upper deck, and have a strong protected roof-plate 4 in. thick. Each barbette contains a 28-cm. breech-loading gun, the gear for turning the gun and hoisting the ammunition being below the protective deck. The turn-table itself is constructed of steel plates and angles, and is supported on cast-steel rollers travelling upon a cast-steel roller path at the level of the deck.

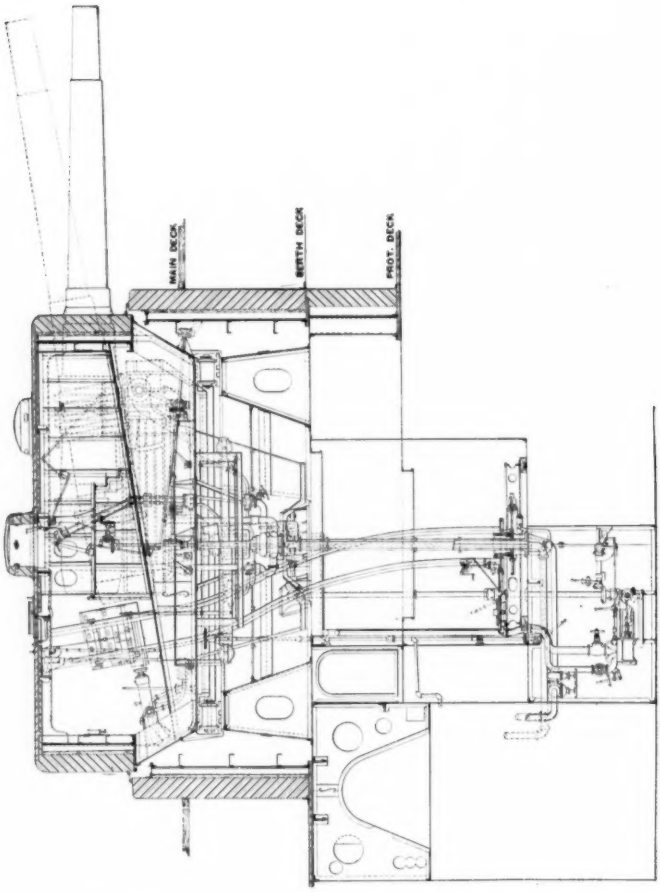
Of all the modern navies, however, that of Japan has alone stood



A SPANISH BARBETTE CRUISER—VISCAYA.



A JAPANESE BARBETTE BATTLESHIP—FUJI.

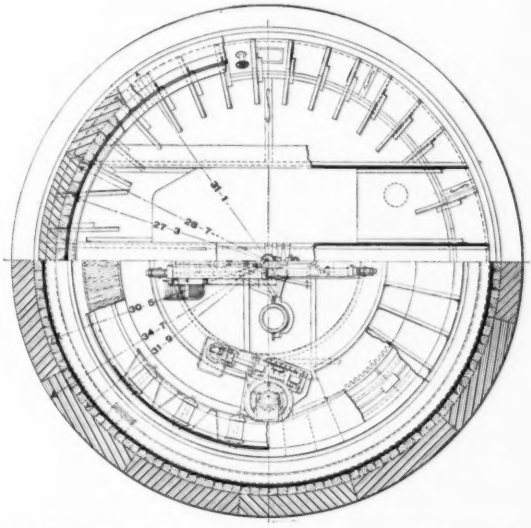


VERTICAL SECTION OF TURRET OF THE U. S. BATTLESHIP INDIANA.

the test of an enemy's fire, so that a word regarding one of her great ships may not be out of place. The Fuji is an English-built ship, and, with her high free-board, her two military masts, and four 12-in. guns mounted in two pear-shaped barbettes, bears a strong resemblance to H. M. S. Magnificent. These barbettes are connected to the side armor by heavy armored screens, the maximum thickness of the barbette armor and that of the conning tower being 14 in. The vessel

has a total length of 400 ft., a width of 73 ft., a draft of 26 ft. 6 in., and a tonnage of 12,450, and is propelled by twin screws driven by engines developing 13,500 horse power, and capable of developing a speed of 18¼ knots.

Returning now to the United States, we know of the absolute cessation of all naval construction for many years after the civil war; how the navy was allowed to deteriorate until the ships in commission were incapable of sustaining the shock of a single shot from any of the vessels owned by England, France, or Italy. Then came the renewal of activity, resulting in the construction of vessels that stand in the front rank in design and probable efficiency. Naturally the turret



HORIZONTAL SECTION OF TURRET OF U. S. BATTLESHIP INDIANA.

has been developed, and we shall see that the American navy department is responsible for an innovation almost as radical as that of the original introduction of the turret itself.

The Indiana is one of the later additions to the navy, and carries two turrets in barbette, each mounting two 13-in. guns. The vertical and horizontal sections of one of these turrets shows the construction very clearly. From these it will be seen that there is a circular barbette formed of armor plate 17 in. thick and extending from the berth deck to a height of 3 ft. 6 in. above the main deck and

presenting the external appearance given in the half-tone reproduction of the photograph of the after-deck. The turret of 15-in. armor is 31 ft. 1 in. outside diameter, and rises 6 ft. 8 in. above the top of the barbette. It is carried by strong brackets that slope down and in towards the center, forming a ring that rests upon conical rollers travelling over a circular track that is, in turn, supported by brackets rising from the level of the berth deck. The engines and turning gear are located at the bottom of the barbette, below the main deck and well out of danger from the enemy's fire, while the machinery for operating the ammunition hoists is placed still lower, and is far below the protective deck.

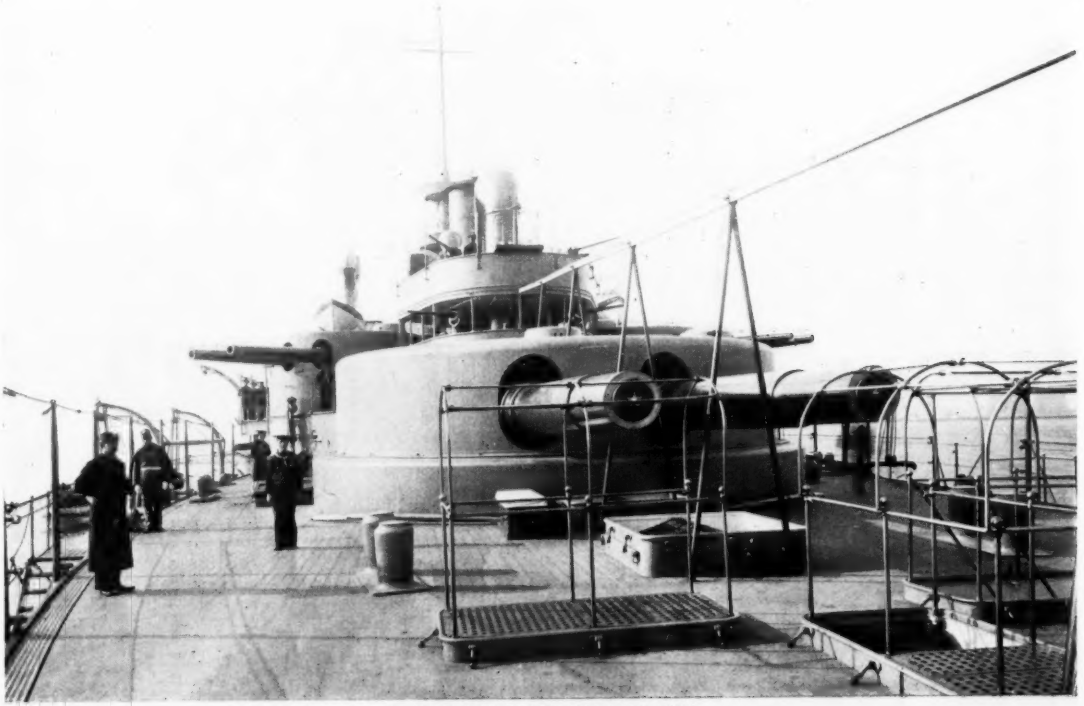
This may be taken as typical of the construction of turret that seems to be most favored by the United States navy, though it has vessels with turrets and no barbette, while on some the guns are mounted behind a protective shield only.

The innovation that is to be made is in the new double-turreted battleships, one of which is to be named the Kearsarge. They are still in course of construction, and their salient feature consists in the location of one turret directly over the other. No photographs of this construction are, as yet, available, but the drawings, kindly furnished by the bureau of construction, show the arrangement more clearly than would be possible by photography.

The two turrets are fixed together so that they necessarily revolve in unison. They differ, too, in plan, from all that we have, thus far, considered in that they are elliptical, though, of course, they must revolve upon a circular track. The upper turret is formed of armor plate 11 in. thick upon the fighting side and 9 in. at the rear, while that of the lower turret is 17 in. and 15 in. respectively.

The major axes of the turrets on the outside are 19 ft. and 32 ft. 3 in., with minor axes of 16 ft. 6 in. and 26 ft. From the armor deck to a height of 2 ft. above the main deck there will rise a citadel 15 in. thick on the front face and 12½ in. at the rear. This is circular, and will serve to protect the track upon which the turrets travel as well as the racks and turning gear, which are located below the lower edge of the turret, as in the Indiana.

As in every new device, opinions differ as to the advisability and practicability of the new design. When the "Monitor" was built, the scoffers were loud in their ridicule, and strenuous were the assertions that the men in the turret would be injured by the concussion of the gun; and the same fear has been expressed regarding the effect of the firing of the upper guns upon those in the lower turret. It is, however, merely a surmise, and there is no precedent to lead one to think that such would be the case, for the discharge of guns from ordi-



AFTER DECK U. S. BATTLESHIP INDIANA.

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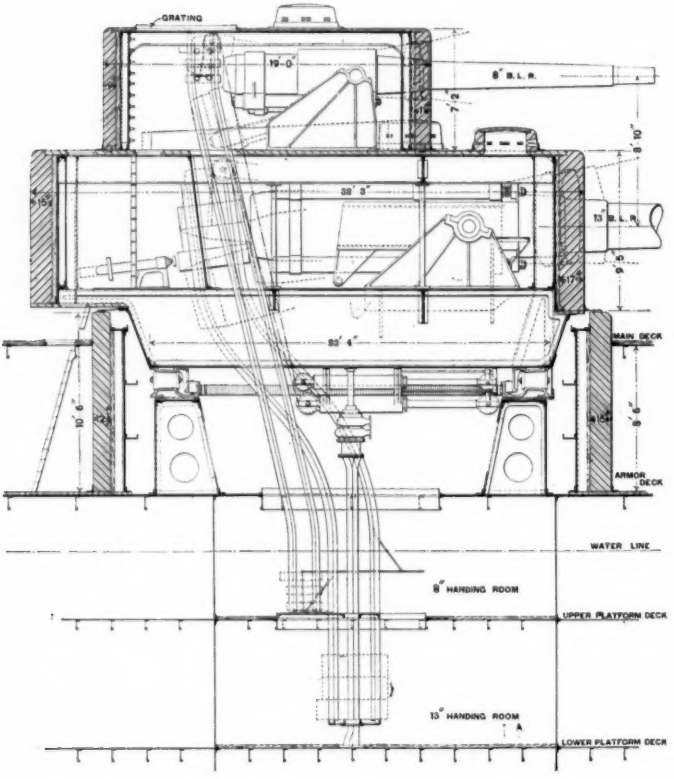
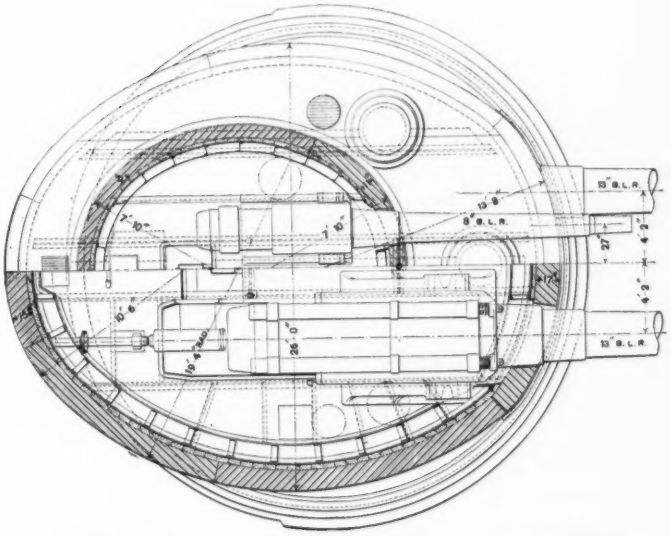


VERTICAL SECTION OF THE DOUBLE ELLIPTICAL TURRET OF THE KEARSARGE.

nary turrets has never been known to do any injury to men between decks.

It should be borne in mind, however, that we have as yet but a very meager record of what effect the firing of one of the heavy guns across the deck would have. In practice they are fired abeam, possibly for the very reason that there is fear of the effect on deck. Certainly the experiment would be worth the trial, even to the extent of causing a sudden and splintering removal of the planking from the quarter deck. We do know, however, from the experiments at Indian Head, that the crushing effect of a discharge is very great upon any surface immediately below the muzzle.



HORIZONTAL SECTION OF DOUBLE ELLIPTICAL TURRET OF THE KEARSARGE.

Thus the turret has grown from the single "cheese box on a raft," to be the typical and main means of defence for the large guns in all of the navies of the world; but, just as it has reached the maximum of its strength and its guns have risen to unheard-of diameters, throwing costly projectiles through a trajectory of many miles, discussion is rife as to whether or no it is the best method of construction, involving, as it does, comparatively low speeds,—speeds too low to make them available as commerce-destroyers. It is the torpedo boat that is now advocated for offence and defence, and its advocates claim that, as the little kingbird, by its rapidity of movement, can drive the hawk or the crow before it, so a swarm of these fleet little craft would soon whip the greatest battleship of the world. The fact is that in the original idea as conceived by Ericsson there was probably no intention that the turret would ultimately become *the* means of gun-protection; certainly he could have had no idea of the growth that ordnance would attain, since at that time a 11-in. columbiad using fifteen pounds of powder was the heaviest gun available. This increase of ordnance is, however, probably a direct result of the increase in the thickness of armor plate, for the struggle of the one has always been to throw a shot that would pierce the

other, amounting at times to an almost amusing inconsistency, as when a navy board awards a contract for armor plate that shall be guaranteed to withstand the impact of a projectile the strongest yet known, and then immediately asks the same contractors to furnish a better projectile to pierce their own armor. The increase in the size of the ships, with the necessary raising of the turrets high above the water-line, have tended to a decrease in the stability of ships that in a few instances has necessitated a practical reconstruction, until it seems as though the limit has about been reached, which may perhaps be one of the reasons why the turret has not yet convinced the naval world that it is the fittest to survive; probably nothing but a great war can settle the question as to whether it is better to depend upon strength or speed. We may well ask the question, which shall it be?

REVIEW OF THE ENGINEERING PRESS

The Future of Marine Engineering.

IN the September number of this magazine, Lieut. Ridgely Hunt presented an exceedingly interesting account of progress in marine engineering during the last fifty years. Others are forecasting what may be expected in the future. It is not probable that we are near the end of the splendid line of advance portrayed by Lieut. Hunt, and *The Iron Age* (August 5) devotes a couple of columns to a prognostication of what it considers the probable future of naval practice. It might be thought by those unfamiliar with marine engineering that the great navies of the world and the merchant shipping interests are distinct, and ought to be considered separately; the contrary is the correct view. The military marine and the merchant marine are interdependent. Many of the existing English steamers now devoted to peaceful commerce were specially constructed for use as war vessels, if occasion should require. The practice in steam engineering on merchant ships and on war vessels increases every year in similarity. Improvements first introduced and used in the merchant marine have been adopted in the military marine, and *vice versa*. In all places where the British government has developed an important commerce, as in the Argentine Republic, the facilities provided for accommodating her merchant vessels are accompanied with facilities for coaling, docking, and repairing the war vessels with which she guards her merchant marine in all parts of the world. So much for the intimate relation between the military marine and the merchant marine. *The Iron Age*, in reviewing the tendencies of the present time in their probable effect upon future practice, appears to think it doubtful that steam jacketing will be continued. As to the piston-valve, it considers it possible that it may be superseded by the Corliss valve, as the conditions which formerly interfered with the use of a rocking valve have considerably changed. Water-tube boilers, it is thought, will, in the end, be generally adopted for war-vessels, and the reasons for this opinion are stated; they are the admitted advantages of water-tube boilers, which our contemporary believes sufficient to more than compensate for the also admitted disadvantages, for marine use, which this class of boilers has hitherto presented. The survival of one or the other systems of forced draft—to wit, the air-tight fire-room and the close-ash-pit system—is yet indeterminate, but forced draft of some kind is a probable feature of future marine engineering. "The ventilation of a ship is a very important problem. The most successful installations for war-ship ventilation provide numerous branch pipes on both the exhaust and the supply service, the one preventing the accumulation of hot, stale air, and the other insuring a supply of fresh air. It is very necessary, where men are working in a confined space below decks, to provide a proper current of air. In the ventilation of residences, school-rooms, and office-buildings drafts are studiously avoided by the engineer, but in a hot, confined space, where steam machinery is in operation, unless a blast of air is playing upon the perspiring bodies of the men on duty, there is but little benefit derived. The free perspiration which is always experienced in such situations insures the men against taking cold. It is not enough, when considering the ventilation of a space on board ship, to take cognizance of the temperature alone. The precise nature of the atmosphere is not well known, in spite of recent discoveries of new elements therein, but experience has demonstrated that a liberal supply of fresh air is necessary, if the body is to be kept in full vigor. . . . A ventilating problem yet to be solved is encountered in foggy weather. In this case the air is not only saturated with moisture of evaporation, but contains tiny globules

of moisture in suspension. No matter how vigorously the blowers are run in damp weather, the evaporation of bodily moisture is too insignificant to keep the men below deck cool and comfortable, and their efficiency is, of course, very much impaired while such weather lasts. It is much to be wished that some practicable device for separating the moisture may be invented. A scheme that has been proposed, and even tried with some success, is that of heating up the incoming air so as to increase its capacity for moisture; but, although this scheme is not so unworthy as it might appear, yet it does not afford the desired solution." It is maintained that a degree of efficiency and economy in the working force of the navy comparable to that secured in the working force of a large factory has not been obtained, and that, from the nature of the case, it is quite impossible to attain to such efficiency. Nevertheless, it is believed that a considerable advance in this respect could be made through the application of common-sense methods. "In the first place, the naval service ought to be of such a character as to attract to itself the very flower of our young manhood. The recruiting office should be able to state truthfully to its applicants that the navy offers a career that any young workingman may be glad to take up. Good pay, kind treatment, healthful surroundings, occasional shore duty, a neat and attractive uniform, and a reasonable amount of recreation,—these are some of the requirements that a young man of character, health, and skill may reasonably insist upon before affixing his name to three years' enlistment papers."

Western Mill Construction Defective.

WITH reference to safeguards against fire in the construction of western mills, particularly chlorination and cyanid mills, *The Engineering and Mining Journal* (July 17), in an article on "Precautions Against Fire in Metallurgical Works," criticises the construction of this class of buildings, and pays a high tribute to the system of slow-burning mill construction developed in the New England States, which it recommends to the consideration of western mill-owners. Even with such construction, it is doubtful whether gold and silver mills will ever get the low rates of insurance allowed to mills in more thickly populated regions, where facilities for extinguishing fires are greater, and where "the moral hazard" is not so great. Most western mills are said to be constructed of timber, and many of them have timber roofs, although corrugated iron is often used for roofing. "The roof is sometimes supported by trusses, leaving clear working-rooms; but, more frequently, it is borne on posts stiffened with angle-braces and cross-beams, the whole forming a forest of timber, which not only obstructs the light and access to the machines, but adds a good deal of inflammable matter to the structure. . . . Little attention is paid to regularity, and breaks are made in the roof, cupolas for elevators are stuck on, and gables are obtruded wherever necessity dictates, the result being a multiplication of dark, more or less inaccessible cock lofts, in which combustible matter may accumulate." Such accumulations are easily ignited by the careless use of a match or a pipe, and usually total destruction is the result of a fire in such a building. The drying and roasting furnaces, especially when erected on hillsides, in cramped situations, are a prolific source of conflagration. The Rosebud mill fire at Cripple Creek was caused by such a furnace. Great carelessness in allowing wood in close proximity to furnaces, and sometimes even in contact with them, exists. An instance of the ignition of a wood partition, abutting against the walls of an assay furnace eighteen inches thick, is cited as an evidence of this carelessness and the danger attending it. Among precautions against fires in such mills watchfulness and the prevention of combustible accumulations in unused or little-used places rank first.

The Limits of Regulation for Water-Power Plants.

IT has been found impossible to regulate the speed of any kind of motor in-

stantaneously with and proportionally to changes in the amount of work it is required to perform. The change in the load must be first initiated, and the regulation of the speed must follow. There must, therefore, be an interval of time between the beginning of change in load and the beginning of the regulation, and one of the things to be aimed at in the construction of an efficient governor is the reduction of this time interval to the lowest possible limit. Now, while changes in velocity bear a strict relation to the force in action, and, with a given force, require a definite time for their accomplishment, a change of load may be instantaneous. The problem of making a good governor therefore involves the correlation of sudden changes of load with gradual changes in velocity, and in such manner that the former shall control the latter. But, as the one must occur before the other, some change in velocity cannot be avoided. Delicacy of action in a governor, therefore, involves not only the reduction of the interval between change of load and the beginning of the control, but also the power to prevent a wide change of velocity during a subsequent short interval. Mr. Mark A. Replogle, in *American Machinist* (Aug. 19), says that "the regulation of the speed of a water wheel in a power plant is determined by four distinct factors, to wit, (*a*) changes in load or requirements of power; (*b*) time for gravity to generate power; (*c*) capacity of the plant for stored energy; and (*d*) the governor mechanism that should automatically combine the above three factors in such a manner as to obtain even speed or good regulation." He then proceeds to show that the speed of a plant is the resultant of the force which drives it and the force which opposes its motion. When either of these forces varies, the speed will vary, unless the other force is proportionately and simultaneously varied. We have seen that simultaneity is out of the question. It follows that any change in the driving power or in the load must result in some change of speed. The lowest possible limit of this change may be said to be reached when the capacity for storage of energy is infinite; but this is, of course, a theoretical limit, entirely impracticable in engineering practice. Its consideration, however, leads to the principle that, the larger the capacity for storing energy can be made, proportionately to the possible changes in load, the more perfect will be the regulation. This is the well-known principle upon which a fly-wheel acts to prevent sudden wide fluctuations in speed, when sudden changes in load occur; but a fly-wheel, while it prevents sudden changes in speed, will not prevent gradual increase of velocity. Now, Mr. Replogle shows that the time element in water-power regulation is more important than in steam-engine regulation, owing to the nature of the moving mass (water-column) from which the power is derived. Water being practically inelastic, if confined in a pipe or flume, the force required for the stoppage of the motion of the mass will be a function of the length of the pipe or flume. He therefore advises that, where refined regulation is desired, long horizontal pipes should be avoided, and that the power-supply should all be under the direct action of gravity, and move in a line with it.

Roasting Previous to Cyaniding.

WHILE the idea has been prevalent that treatment of ores with potassium cyanid does not require previous roasting, Mr. Wallace Macgregor, in *The Engineering and Mining Journal* (August 14), says truly that a higher percentage of gold is obtainable by calcination. He also asserts that in many cases the increase of yield through roasting prior to cyaniding has been so important that the method has come to be recognized as having passed the experimental stage. The method is most applicable to ores composed of veins of quartz or other rock with gold-bearing iron pyrites distributed through it. "The important changes brought about are, first, keeping the cyanid solution freer from soluble salts than when raw ores are treated; second, making a very high percentage of gold in sulphid ores easily extracted by cyanid solution in subsequent treatment; third, an equal or less con-

sumption of cyanid, with a greater extraction of gold over that obtained on raw ore; fourth, the ability to treat low-grade, silicious ores, carrying the gold value in iron pyrites, without previous concentration; fifth, causing clayey ores to lose the water of hydration, and thereby rendering them porous and making the filtration of the solution much more rapid." Mr. Macgregor cautions those who wish to experiment upon roasting and cyaniding that "they must obtain dead roasted ore before attempting to extract the gold," and adds that "those starting with laboratory experiments will soon find that, by roasting with a very low heat, and a short time in a muffle, they can extract a very high percentage of gold, but that they are doing so at the expense of the cyanid." The importance of dead-roasted ore is insisted upon. Operating with partially-roasted sulphid ore is working under the most wasteful conditions, and the chemical reasons why this is so are very clearly set forth at length. A quick and satisfactory method of testing whether the ore is dead roasted or not is as follows: "Take samples of the roasted ore at the discharge end of the furnace, cool, take from 100 to 150 g., place in a beaker with some 200 c.c. of water, stir this by shaking for about a minute, then filter into a beaker flask, and to the filtrate add a small quantity of cyanid solution, made up to the same strength as that used in the regular work of the plant. It is best to add the cyanid solution slowly and carefully, noting the result. If no cloudiness at all appears, the ore is dead roasted, or at least well fitted for treatment by cyanid solution, and the consumption of cyanid will be normal. If a brown coloration takes place, there are still some soluble salts of iron left in the ore, which will cause a somewhat higher consumption of cyanid, and may lead to a precipitation of compounds of ferro-cyanid in the zinc bottles. If, on addition of cyanid to the filtrate, a blue colorization, soon becoming a greenish blue precipitate, is formed, then the ore is very badly roasted, and one may look for a high consumption of cyanid, and the circulating solution will be made foul." It is also indicated that the economy of the process depends upon conditions varying with different ores, and that, therefore, no general determination of this point can be made. It is admitted that there are ores of so low a grade that roasting them would not pay, the cyaniding of which may, nevertheless, pay a fair profit. It is also admitted that roasting is not an economical process with heavy sulphureted ores and concentrates. In conclusion, it is recommended that laboratory tests for determining the advisability of roasting should be supplemented by small plant tests with from one to ten tons of dead-roasted ore.

Oil-Coated Ballast.

ONE of the innovations in railroading now on trial has been made the subject of experiment on the West Jersey and Seashore division of the Pennsylvania railroad system. This innovation (patented by Mr. James H. Nichol) consists in the application of heavy mineral oil of low cost to the roadbed of a railway, including sides and slopes, the object being to prevent the rising of dust therefrom during the passage of trains. A sticky material used for such a purpose must be insoluble in water; otherwise it will leach away and its supply will be expensive. The inventor, in a letter to *The Railway Age* (August 6), sets forth the purposes of the invention as follows: "Probably from the first building of railroads, gravel, such as is found along the lines of the roads, has been used for ballast, and, if of proper nature, porous and free from clay or loam, so as not to retain water, it is one of the best substances yet used; track laid on such a foundation is elastic, therefore making the riding in cars comfortable, as compared with the more rigid stone ballast. This same elasticity is a benefit to the ties, and particularly to the rails, the latter, when placed on a rigid support, being in the position of a piece of metal between an anvil and a hammer, the hammer being the moving train. Track laid on gravel ballast is more quickly and cheaply repaired than when on stone, the cost of ordinary maintenance and for labor in renewal of ties

being about one-half. The principal reason for the discarding of gravel ballast on many railroads has been the discomfort to passengers arising from dust. As substitutes various materials have been used, such as cinders from anthracite and bituminous coal, burnt clay, crushed stone, etc. Each of these substances has some dust connected with its use, stone having the least. Cinder ballast is thought by some to affect injuriously the life of the cross-ties, rotting the wood with which it comes in contact. Stone ballast, when first applied, and after being washed by rains, is clean and free from dust, until such time as it becomes filled with material,—largely cinders thrown from the stacks of freight trains,—and in this condition requires to be forked out and cleaned at large expense; the tamping of the ties, to obtain and preserve a level surface of the rails, results in the stone being crushed under the ties; and, if of a limestone character, a condition resembling a cement trough is formed under each cross-tie, which catches and retains rain-water, causing the tie to decay. Cinder ballast, after being newly applied, requires several rainstorms to wash it free from dust, and then it is reasonably clean, until the work of surfacing the track, or renewing cross-ties, stirs up the cinder from below the surface and exposes a new layer of dust. After a few years' use, cinder becomes pulverized by repeated tampings, and is then a more objectionable dust than that from gravel, being dark in color. Experience shows that the oil produces equally good results with cinder as with gravel or sand." Two thousand gallons of oil per mile are used. The distribution is effected by special apparatus illustrated and described in the journal quoted.

New Method of Constructing Dynamos.

MR. ALBERT W. SMITH, in *The Electrical Engineer* (Aug. 12), describes and illustrates a new method of dynamo-construction, and sets forth his reasons for supposing this new construction to be an advance upon hitherto-existing designs for dynamos. He proposes the rearward displacement of the field magnet coils "from the neutral or commutating points," and winding them "in or across the flux paths of their respective magnets and close to the armature." By these changes he expects to obviate "the employment of large field coils, which impose the necessity of long magnet cores, which in turn imposes a large and heavy yoke structure." He argues the case as follows: "It is obvious that the magnetism generated by any given term or section of a field coil must pass through that turn or section, though it need not pass through all the turns or sections of the coil, but may leak out through the side of the coil adjacent to its own turn or section; it follows, therefore, that the magnetism generated by a field coil cannot be shifted forward further than the width of the coil. It is, then, only necessary to wind the coils entirely back of the neutral lines, and as close to the armature as practicable, to insure the desired freedom from field distortion; this is made possible by using a field magnet structure which has on one side of its neutral points a single wide pole, or polar area, and on the other side thereof a plurality of smaller poles, forming between them coil-containing spaces (or, instead of plural poles, a single large coil space), in which space or spaces the coils are wound." The diagram which accompanies the article under review makes the above statement clearer, but we think electricians will understand it without such aid. "By this method of winding the field coils, a long external air-path of very great reluctance is opposed to the armature magneto-motive forces, thus obviating the present necessity for a large air-gap reluctance; the size of the air-gap is, therefore, imposed entirely by the mechanical conditions, and can be made very small, while the core teeth can also have the same low reluctance as other parts of the magnetic circuit. The magnets, consequently requiring only a small fraction of the magnetizing energy now necessary, and the coils being correspondingly smaller, consequently require proportionately less winding space; thus insuring a field magnet structure which has about the same weight as the armature, or some-

what less." Another innovation proposed by Mr. Smith is intended to obviate the present method of commuting under the leading pole corners, in which method it is necessary to provide for adjustment of the brushes, and to use carbon brushes, which cause a waste of energy. Mr. Smith proposes to entirely prevent the self-induction caused by the spark, "by interlinking the coils at the moment when their segments leave the brushes." He thus aims to oppose to the magneto-motive forces, due to current increase, counter magneto-motive forces, which, being equal or superior in strength to the former, "will suppress those due to the armature coils, and thus absolutely prevent the existence of any spark causing self-induction in the commutable coils, thus insuring sparkless commutation, and enabling the use of metal brushes, which may be either solid, laminated, or of gauze construction, and which remain in a fixed position for all variations of load and speed." We can not deal further with this suggestive article. We do not understand that the proposed innovations have yet been carried out in a practical machine. Till this is done it will be too early to estimate the value of the changes proposed.

The Coffer-Dam Process for Piers.

UNDER the above title Mr. Charles Evan Fowler, in *Stone* for August, commences a discussion of the use of coffer dams in the construction of piers, tracing the methods of constructing bridges from their earliest employment up to the present time, and classifying the different kinds of bridge-foundation construction. He thinks that there are four general classes of construction, and that a fifth may be added. First there is "the method with open caissons; second, the use of piles with a capping of coarse concrete about the top; third, the use of piles after the manner of the French *encaissement;* and, fourth, the use of the coffer dam. A fifth method might be added, in which the bridge is built on dry land adjacent to the stream, and the river diverted to a new channel afterwards excavated under the new structure. This is, however, rather an avoidance than a solution, unless the river is to be diverted in the course of improvements." We cannot recall any instance of the employment of the latter method on a scale sufficient to render such construction of historical importance. The method has, however, been used to a very limited extent in railway construction, principally in culvert construction, and a culvert might possibly be defined as a bridge over a small stream. If any notable example of the employment of the method exists, Mr. Fowler does not cite it. He states defects of earlier methods which led to the employment of coffer dams. Until this device was invented, a careful examination and inspection of the bottom on which the foundation was to be placed was impossible. The use of coffer dams having fallen into disfavor since the advent of the pneumatic caisson, the author endeavors to trace the causes of this disfavor, and to prove, by the citation of successful examples of the use of coffer dams, that this prejudice is in great measure unfounded. One reason why the coffer dam has sometimes proved unsatisfactory is the fact that the specifications leave too much to the judgment and integrity of the contractor. As an example of complete and thorough specifications for coffer-dam construction, he cites those prepared by Robert Stevenson for the construction of coffer dams for the Hutcheson bridge over the Clyde at Glasgow. These specifications are quoted as a model of explicitness, and Mr. Fowler sees in the want of similar care in more modern specifications a reason why coffer dams have so often proved unsatisfactory. The subsequent parts of the series will give successful examples, and will deal with first essentials of construction and expedients for meeting accidental emergencies.

Competition for the New York Public Library.

THE hope that a building of so much importance as the proposed New York Public Library will be a worthy exponent of American architectural talent is proba-

bly shared with us by every lover of art. It will not be enough that the interior design affords every facility and convenience for library work, both as regards its administration and its usefulness to readers; its exterior design should rival in artistic merit any other building within the limits of Greater New York. The application of the competitive system to the securing of such a design, however, does not greatly encourage the hope above expressed, in view of the many previous failures to gain satisfactory results by this method. Yet, in this instance, it would be difficult to suggest any substitute mode of procedure that would equally content the American public. We say "American public," for it cannot be reasonably supposed that interest in this matter will be confined within the limits of the newly-consolidated city, notwithstanding that in the preliminary and final competitions which will be instituted the former will be limited to the practising architects of Greater New York. The conditions of this preliminary competition are set forth by "Jack Shingle, Architect," in *Architecture and Building* (Aug. 7). The first thing that will impress the thoughtful reader of these conditions is the smallness of the prize—$400—offered to each of the producers of the twelve best designs. The ridiculously small sum of of $4,800 dollars is thus shown to be thought sufficient to enlist the best efforts of twelve competent architects in this work. Of these only six can be selected for the final contest, and these must again compete with six others probably not selected from the first competitors. And even if the design of one of the original competitors should be chosen, he will not be able to reap the full glory and profit of the award, because the committee reserves the right to associate with him a consulting architect, who, whatever else he does, will share the fee of the successful designer. The reason assigned for the inclusion of six new competitors in the final competition is that the committee wishes to make sure that six leading architects will enter into the competition. The value of this last consideration is apparent enough, but the reasons for not including these leading architects in the preliminary competition are not so obvious. The author under review thinks that a reserve which will prevent an undue advantage to these new competitors will be difficult to maintain, and thinks a fairer way would have been to make the preliminary competition "simply a test of ability, and finish for a different site." As to the right to appoint a consulting architect, "Jack Shingle" presumes it will not be exercised, except a distinct necessity should exist for it. The exercise of this reserved right will introduce a marked and questionable innovation in architectural practice. It certainly is a contingency which cannot fail to handicap the competition, and may possibly deter from competing some who would otherwise submit designs.

Spontaneous Ignition of Coal.

THIS subject, of great importance to the coal-carrying trade and to marine underwriters, as well as to first-hand shippers of, and dealers in, coal, has received considerable attention of late. If all the conditions favoring the spontaneous combustion of coal are not fully determined, it is not the fault of the investigators who are seeking to make sure that no such condition eludes their pursuit. Among the latest presentations of the subject is a paper read by Mr. John L. Howard before the fifth annual meeting of the Pacific Gas Association, and printed in *American Gas Light Journal* (Aug. 9). While Mr. Howard thinks that the true cause of spontaneous combustion of coal has been discovered, the study of prevention and control has not, in his view, progressed very far. He traces the cause to the accumulations of fine coal directly under the hatches of vessels which occur during the process of loading. "In the process of loading ships with bituminous coal, . . . it will be found that, whether the coal be dropped from a chute or spout that overhangs the hatchways of the upper deck, or whether the coal be lowered through the hatchways and dropped in the hold with a minimum of fall, the forming pile will

assume the shape of a cone. In this process there will be breakage dependent upon the friability of the coal and the amount of the fall. This breakage will be sensibly increased, if, in addition to the drop, the coal is allowed to go into the ship with the velocity due to the steep incline of the loading chute. There will be a shattering of lumps and a compacting of the mass because of the impact of blows from the falling body of coal. . . The fine coal resulting from this method of loading a ship lies in an inert mass where it falls, whereas the tendency of the lumps is to roll down the sides of the cone toward its outer edges." Having thus explained the manner in which these masses of fine coal are accumulated, it is next shown that after their formation they generally remain as formed throughout the voyage, always incurring the danger of, and frequently resulting in, spontaneous combustion, with loss of ship and cargo. Whether this combustion results from the chemical combination of atmospheric oxygen with the carbon, or with the sulphur of the coal, or with both, it is certain that, the larger the surface of any substance exposed to chemical reaction in proportion to its mass, the more active will be the reaction, and the more rapidly will the temperature be raised by the heat generated in the reaction. The finer a substance is pulverized, the greater will be the sum of its surfaces in proportion to its mass or weight. The combination of oxygen with the sulphur of the coal is the explanation of the spontaneous combustion of coal given by Berzelius, and is the more generally accepted explanation. In every pile of coal there exist two of the conditions that obtain in active furnaces. In the one case the combustion is made visible and intense through the greater rapidity with which the chemical action is made to occur after heat has been first applied; in the other the combustion is as surely taking place, though not apparent until the self-evolved heat reaches a point where the conditions are identical. The danger is not confined to bituminous coals, though these are more frequently the subjects of spontaneous combustion. Prof. Vivian B. Lewes holds the opinion that it is the reaction between the hydrocarbons and atmospheric oxygen that causes coals to heat; and perhaps this theory accounts for the fact that bituminous coals, being richer in hydrocarbons, are more liable to heat. If the plausible theory that spontaneous combustion originates in the finely-pulverized coal left in undisturbed masses in ships or in land-storage be the true one, the avoidance of such sources of danger does not seem difficult, though it might, in some measure, retard the rapidity with which vessels are now loaded with coal, and somewhat increase the cost of handling.

The Largest Hydro-Electrical Power Plant.

IT is announced in *Electrical Review* (Aug. 4) that Messrs. Stewart & Company, owners of the St. Lawrence Power Company, have placed with a strong English syndicate bonds to the value of three million dollars, for developing what will be the largest power plant in the world at Massena, N. Y. The contracts for the construction have been placed, and the work has already been commenced, under the direction of Mr. John Bogart, of New York, chief engineer, and Messrs. Kincaid, Waller & Manville, of London, consulting engineers. The contracts placed are as follows: "Excavation of canal, building of power-house, intake and outlet construction, etc., with the Lehigh Construction Company of Bethlehem, Pa.; fifteen 5,000-h. p. generators with the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa.; fifteen 5,000-h. p. turbines, with the Stillwell-Bierce and Smith-Vaille Company of Dayton, Ohio. This enormous output of power has been, it is said, nearly all spoken for in advance, and will be taken within moderate distances of the generating plant. The favorable conditions for the establishment of a power-generating plant at Massena are probably unequalled in any part of the world. The detailed description of the entire plant, as now planned and in progress, is illustrated by a map, and the favorable physical conditions at this point are set forth.

THE BRITISH PRESS

Cottage Hospitals.

THE term contained in the above title will probably be new to most Americans. So far as we know, nothing exactly corresponding to the English cottage hospital exists in the United States. The movement for the institution of the cottage-hospital system does not appear to have been in the direction of economy, however much it may be approved from a humanitarian standpoint. The origin and the nature of the movement are set forth in a paper by Thos. W. Aldwinckle in *Journal of the Royal Institute of British Architects* for July, as follows: "The cottage hospital movement began, as many excellent things have done before, in a very small way; nor was hostile criticism or unfriendly indifference wanting. The late Mr. Albert Napper, of Cranleigh, was the author of the first work on the subject. But he was also, undoubtedly, the actual founder of the movement, for he established the first cottage hospital at Cranleigh, in Surrey, in the year 1859, by the conversion of an ordinary Surrey cottage into a hospital at a cost of about £50." The object was to extend to country districts the benefits of a hospital system. That this could be done very imperfectly at best seems obvious; but, even if great and numerous imperfections exist, there can be no doubt that many sick and indigent people can thus receive far better medical treatment and nursing than they could obtain through individual charity. The benefits which, it is claimed, these institutions render to society are that the cottage-hospital system provides against the evils of indiscriminate medical relief; it enables the patient to pay something, even when unable to pay the whole cost of medical treatment as ordinarily administered; each doctor is free to follow his patient into the hospital wards; and in these institutions the sick may obtain food, supervision, better hygienic conditions, and careful nursing. The system has received the general approval of medical men, and has thus, apparently, an assured future. Now, though books have been written upon the subject,—in fact, Mr. Aldwinckle's paper is in the nature of a review of a book,*—and, although many excellent plans for these small hospitals have been prepared and published, very little real advance seems to have been made in cottage-hospital architecture since the institution of the hospital at Cranleigh, which, Mr. Aldwinckle says, "remains a very good type of the small cottage hospital pure and simple." The building was a very old cottage of the Surrey type, given by the rector of the parish, and, as adapted to the purpose by the late Mr. Napper, provided for four beds on the first floor, the administration being on the ground floor. "The nursing is placed in the charge of a trained nurse under the supervision of a committee. Other small hospitals, since established, differ very little in details, except in size. They range from four to thirty-two beds in capacity. Some have a room for convalescents on the first floor." But a hospital containing thirty-two beds seems a development beyond what the term "cottage hospital" ought properly to include. It may be, as the United States becomes more thickly settled, and approaches conditions of living similar to those which obtain in thickly-populated agricultural districts of England, that the establishment of these small hospitals will become expedient here. Be this as it may, whoever shall write a comprehensive history of the hospital architecture of the nineteenth century will find in the English cottage-hospital the materials for an interesting chapter.

The New Docks at Buenos Ayres.

TRANSPORT (Aug. 6) quotes from the *Buenos Ayres Standard* a statement that the Buenos Ayres docks (claimed to be the largest, newest, and best equipped on the American continent) rank in importance with the federalization of Buenos

*Cottage Hospitals. By H. C. Burdette. London, 1896. The Scientific Press, Limited, 428 Strand. Cloth, 10*s* 6*d*.

Ayres. The magnitude and importance of these harbor improvements may be inferred from their cost—£7,000,000 sterling. They are also said to have proved a financial success. Monte Video, on the opposite side of the river, now waits for some attempt to deal with the problem of accommodation for shipping. *Transport* says: "In order that each section of the Buenos Ayres works might prove dividend-earning as soon as completed, each basin or dock was designed so that it could be opened as soon as completed. The South Basin, covering thirty-five acres of water space, was opened in January, 1889; dock No. 1, in January, 1890; dock No. 2, in September, 1890; the third dock, in 1893; the fourth, in 1896; and the North Basin, in March last." The docks and their equipment were originally intended to cost £4,000,000, but additions to the original scheme increased the cost somewhat more than £3,000,000. "Numerous warehouses of enormous dimensions, all of which are crowded with goods and produce, have been erected; two graving docks, now the largest in South America, have been built for repairing warships and ordinary steamships; the hydraulic machinery has been increased, and many miles of additional railways laid. The cost of all these vast improvements is said to compare very favorably with the cost per acre of the docks at Liverpool, London, and Antwerp. Apart from the important impetus which the improved shipping and warehouse facilities have given to the general trade of the Argentine Republic, the docks, crowded as they already are, show at present a net return of nearly four per cent. on the outlay."

Dangers Connected with the Supply of Electricity.

A SUMMARY of a report of a committee appointed by the home office, after the inspection of twenty-six different generating stations and sub-stations, with the assistance of a number of experts, is printed in *The Architect & Contract Reporter* (August 6). The report states the existence of the dangers named in the following abstract. First, with the employment of accumulators, when the plates are overcharged, there may be generated an explosive gaseous mixture. Such a mixture is easily ignited from a spark or flame. It is, therefore, seen that care should be exercised not to overcharge the plates of a storage-battery, and that some caution should be used in approaching such batteries with an open flame. In electrical generating works there is danger of serious injury, or even death, from shocks caused by contact with conductors. This danger is great, provided any two parts of the human body are made to touch, even imperfectly, conducting materials differing in pressure by one thousand volts or more. A much less difference in voltage is dangerous, and may be fatal when there is full and perfect contact with the flesh. It is, however, noted "that, of fourteen fatal accidents which have occurred in England during the last five years, in not one case was the pressure below one thousand volts." The highly-charged metals, protection from contact with which should be provided, are in the dynamos, switchboards and their connections, high-pressure mains, transformers, and the lamps of series arc-lighting systems. "In the case of high-pressure alternators or dynamos it should be impossible for an attendant, whilst oiling the bearings or cleaning the frame, to make any contact with any live metal. Efficient guards should be arranged over the collectors or commutators, terminals, and leads, for this purpose." The committee does not recommend the use of oil-cans with insulating handles, and takes the position that, if all the live metal-work is well guarded and the frame earthed, an insulated oil-can is unnecessary. While the front of a switchboard should be easily and quickly accessible, the back should be accessible only to "skilled persons having the right and means of entry. This latter is a very necessary precaution, as it is often possible to touch live portions of metal and iron supports or stays which are practically earthed; and a person who is not fully aware of this danger should have no access to such places." The exposure of any live metal work on the front of a switch-

board is entirely unnecessary. Overhead, high-pressure, uninsulated conductors may become dangerous by breaking; or they may cause danger by being brought into contact with buildings through the action of winds. Even if wholly insulated, they are regarded as never free from risk. Underground conductors are considered comparatively safe, as the insulation required to prevent loss of current is, when perfect, always sufficient to protect from serious risk the person of any one coming in contact with the insulating material. But it is pointed out that in underground conductors a defect in insulation, scarcely sufficient to make its presence felt in ordinary working, may allow "the escape of sufficient current to produce instantaneous death." With reference to arc lamps in series it is said that, as these are in many cases placed so high that a ladder must be employed to reach them, a shock, in itself too light to cause serious injury, may in such cases result disastrously by causing the fall from the ladder of the person so shocked. The following regulations for work at front or back of switchboards are recommended, under the assumption that the backs of all switchboards will be kept closed except for the purpose of alterations and repairs: "(*a*) No person except a skilled electrician, or a workman under his personal and immediate supervision, shall be employed when any part is at high pressure; (*b*) no extensive or serious repairs shall be executed upon metal which is at high pressure; (*c*) where the alterations or repairs are not of an extensive or serious character, all metallic parts at high pressure shall be covered by an insulating cap, or protected by some form of insulating covering, only one part, or several at the same pressure, to be exposed at any one time." These regulations are supplemented as follows: A clear, unobstructed space of not less than four feet behind each switchboard is required; workmen on cables or mains are compelled to wear rubber gloves; insulation, throughout their entire length, of all high-pressure conductors in shops or factories is enforced; all examinations of high-pressure mains, wires, machines, or apparatus must be made by skilled electrical engineers, or competent managers or foremen, and, except in case of necessity, no examinations or repairs are allowed while a high-pressure is maintained; use in transformer chambers of "switches that can be conveniently operated from the outside for cutting off both the high- and low-pressure connections of the transformer is compulsory;" and the provisions of means for completely disconnecting arc lamps in series from mains, without interfering with the operation of other lights, is insisted upon.

Water-Tube Boilers in High-Speed Ocean Steamers.

A GREAT deal of wrangling over the merits and demerits of water-tube boilers for marine service has been indulged in, and it can hardly be hoped that the debate is yet ended. There are still many who believe that the older type of marine boiler is the best, all things considered. Nevertheless, water-tube boilers are steadily making their way in marine engineering. We believe it to be the opinion of most close observers that this class of boilers will prevail for steamships. The difficulties to be surmounted in their application to this purpose were great, but modern engineering is not daunted by great difficulties. We have reached the era of high speeds in marine propulsion. It has come in with the era of high steam pressures, and high steam pressures have logically led to the era of marine water-tube boilers. The extent to which this innovation is about to be carried is well indicated in a paper read by M. Sigaudy (July 6) before the International Congress of Naval Architects and Marine Engineers, and printed in *The Steamship* for August. In this paper an example of a marine water-tube boiler carrying three hundred pounds steam pressure per square inch is cited, and the author presents the details of a boiler designed for a large steamship, in which a similar pressure may be maintained. Comparing the water-tube boilers already used in large steamers with those used in Thor-

nycroft's torpedo boats, the author says: "Certainly a great step has been made with water-tube boilers having large-size tubes, and remarkable results have been attained already; but these boilers would never bear the tests which torpedo boats undergo. The tubulous boilers of the latter have supported a combustion of eighty pounds per square foot of fire-grate. Of course, the idea" (in the scheme presented by the author to the International Congress) "is not to put on board of a large steamer a great number of torpedo boilers . . . but rather to adopt boilers constructed on the same principle as these, and adapted to the wants of a long service and great endurance at sea on board of a large vessel. Thus the diameters of the boiler chests must be larger; the tubes that now have about one inch internal diameter will be increased to one and one-half inches, and perhaps a little more. The thickness may also be much greater. Finally, the whole must be combined to make the most of the available space of a large vessel." Without going into the argument made by the author in favor of such boilers as compared with cylindrical boilers, we pass to his conclusion that the reduction in displacement in a large modern steamer directly and indirectly due to the substitution of water-tube boilers for cylindrical boilers may, with the same weight of paying cargo, be three thousand tons; and that, since the dimensions of ocean steamers are limited by the depth of water in harbors, a great increase of speed can be secured only by reduction of total weight. In conclusion, the prediction is hazarded that the introduction of the water-tube boiler into marine service will prove a greater advance than the substitution of the screw for paddle-wheels, the adoption of compound engines, or triple and quadruple compounding.

Portable Recorder for Tests of Metals.

AN attempt to supply a long-felt want in engineering appliances is illustrated and described in *Industries and Iron* (August 6). It is the invention of Gustavus Charles Henning, and the description referred to was first presented before the Iron and Steel Institute at Cardiff. The following abstract will show the purpose of the instrument, and the inventor's idea of what such an appliance should be capable of indicating. It may first be premised, however, that many inventors of eminence in the profession of engineering have essayed to solve this problem. Among these may be named Wicksteed, Unwin, Kennedy, Barr, Gray, Olsen, Mohr, Federhaff, and Grafenstaden. It appears, therefore, that Mr. Henning has undertaken a severe task. He speaks of all the inventions hitherto devised as wanting in some particular or particulars, and it is not unlikely that his own invention may be found wanting in some respect, after its efficiency has been put to the test of actual service under all conditions that may arise. Whatever deficiencies it may develop, it has the immense advantage of being portable; it may be carried to and from the works where tests are to be made in the same way that a steam-engine indicator is carried, and used without the costly preparation required with some of the devices above named. It is in itself also much cheaper than apparatus heretofore used. We shall not attempt a detailed description of it, but will content ourselves with a summary of the essentials which, the inventor claims, should be embodied in such an instrument, and which, presumably, he thinks he has attained. "Such an instrument must be portable and compact, requiring no extra precautions in adjustment or regulation, and, without having the accuracy of an instrument of precision, must be perfectly trustworthy, and as correct as the other apparatus with which it is used. It must cover a wide range of work of short and long, large and small test-pieces, such as are found in general use, and must be applicable to hard and soft materials as well. The apparatus should be applicable in a horizontal as well as in a vertical position. Moreover, it should give a complete record from beginning to end of the test, showing the more important elements on an enlarged, and the lesser on a natural, scale. Thus while elongations within the elastic limit

(yield-point) are very minute and must be recorded on a magnified scale which is trustworthy, changes of length beyond this critical point are very large, rapid, and variable; hence measurement with a steel scale suffices, and the record on a diagram may be on actual scale. This change of scale must, however, be positive, controllable, and at a fixed instant or point, and must not introduce errors in the record. In cases of materials of slight extensibility, however, the entire record should be on one scale from beginning to end, and the instrument should be so attached that it does not nick or injure the material so as to affect its point of rupture or strength." The design of the instrument must also prevent the introduction of errors by slipping or tilting consequent upon changes in shape of the material under test, and must also admit the application of checks upon the accuracy of the instrument at all times. It must also provide for an autographic record of properties of the material by which the effects of hardening, cold rolling, tempering, etc., can be permanently indicated. "With the use of such a recorder, it would become instantly apparent whether the material had been previously strained to raise the elastic limit, as is well known to have been done. Overheating of material would be clearly indicated by the change in curve, and the general uniformity of any lot of material could be determined." The instrument ought also to be applicable to compression tests. The instrument to which, on account of its small size and portability, the name of "Henning pocket recorder" has been given is an ingenious piece of mechanism; it draws diagrams upon paper fixed upon a rotating drum in a manner analogous to the action of a steam-engine indicator. We regret that it is not practicable here to describe its parts and operation in detail, as it is in our opinion, destined to become a useful addition to existing means of studying and ascertaining properties of constructive materials.

Submarine Coal Mining in Spain.

THE *Colliery Guardian* (July 30) says that "the Real Asturiano Zinc Mining Company has for several years worked a colliery at Arnao, in the Asturias, upon a seam varying in thickness up to a maximum of 39 feet, which comes to the surface at about 100 feet to 130 feet above the sea-level, and about 200 yards from the shore. The dip is northerly, or seawards, but, the inclination—23½ degrees—being greater than that of the sea-bottom, the cover increases rapidly in depth; the thickness of the overlying measures of shale and sandstone, which is only 40 meters at the shore line, having increased to 180 meters at the bottom of the mine, now 200 meters below the sea level and 500 meters distant, on the slope from the outcrop." Two different systems are followed, one when the ground worked is above the sea-level and the other when it is below it. The latter, or submarine, has a vertical shaft 76 meters deep, sunk from a point about 20 meters above the sea, the bottom, 56 meters below the sea, being in the seam, which is followed downward by a slope on the dip of 23½ degrees. Working levels in the seam are turned off from either side of the main incline at vertical intervals of about 10 meters, but only the alternate ones are driven through and used as main drawing roads, the intermediate one being cut out, as required by the working.

Removal of Internal Corrosion from the Mains of Waterworks.

THE obstruction of flow and consequent reduction of pressure due to internal corrosion of the mains of waterworks have often caused serious trouble to the engineers in charge. Much study has been given to means for removing the accumulated obstructions arising from this source, which retard the flow, not only by reduction of the interior diameter of the mains, but also by their great increase of friction as compared with the friction of the smoother interior of the pipes when first put down. Any experiences in the successful removal of obstructions thus formed must be of value to engineers who find themselves in the presence of a similar difficulty. Such an experience with the

water mains at Kendal, England, is recounted in an interesting paper by Mr. T. H. Ritson in *Journal of Gas Lighting* (Aug. 3). It appears that there are two distinct districts of water-supply in Kendal, a low service and a high service, in the latter the water being taken from a reservoir 464 feet above ordnance datum. The obstruction arising from corrosion was met with in both these services. When Mr. Ritson took charge of these works, they had previously been in the hands of a private company. He found the state of the mains very bad; through abnormal leakage, waste, and obstruction, the supply was exceedingly unsatisfactory. This unsatisfactory condition of the supply had led to the purchase of the waterworks by the local authorities, and the employment as manager of Mr. Ritson. Increase of the capacity of the works was at once proposed, and this is now in progress, a new reservoir being now partly constructed. Before going to any considerable outlay or extensions, the author recommended the scraping of the six-inch trunk main and a four-inch leading main, with a scraper of the Appold type as modified and improved by Mr. T. Kennedy. As so modified, "the scraper consists of two distinct parts connected by a swivel joint, the front carrying eight steel scrapers, and the rear portion propelling pistons. Leather disks, intersected by radial cuts, and stiffened at the back by lead plates, are placed behind each piston. The springs, with steel scraping edges are arranged in sets of four each,—the set behind breaking joint with the set in front. The cutting edges are set in such a way that, should the scraper encounter anything in the shape of a projection, such as ferule screwed into the pipe, the whole machine will slew, or turn round, and thus pass the obstruction without getting blocked; while the leather packings will fold back, and pass any obstructions that can be passed by the pistons themselves." It is thought advisable to have two sets of pistons, one of smaller size than the other, and to use the smaller size first, following with the larger. The description of the actual work of scraping the mains follows: "Men were posted along the six-inch main running from the reservoir, at intervals of twenty-five yards, with instructions that, directly the scraper passed underneath (which can be easily distinguished by a rumbling noise), each man should shout 'passed' to the one in advance. There were several stoppages of the scraper; but its position was easily detected by the stethoscope, from the sound of the water rushing past. One cause of the stoppage was found to be due to about twelve pounds of lead—the result of a badly-run joint. The scraper was inserted a second time in the hatch-box of the reservoir, and, on the water being turned on, an exciting chase took place, for a distance of 2,523 yards was reached in seventeen minutes. A good deal of filth and corrosion was removed on each occasion, the main being afterward well flushed. One length of main was found to be so badly corroded that, in some places, there was barely a 2½-in. waterway through it; and, as the pipes had not been treated with Dr. Angus Smith's composition, the 'carbuncles' of oxid of iron had coalesced to such an extent, and were, moreover, so firmly fixed to the interior surface of the pipes, that it was regarded as next to impossible to successfully scrape them. In the end, it was deemed advisable to replace the main with a new six-inch one." The experience with the scraping of the 830 yards of four-inch main is not less interesting and instructive. Both give unmistakable positive evidence of the value of the Appold scraper as a means of exploring and cleansing water mains, and negative evidence of the usefulness of Dr. Angus Smith's composition as a preventive of corrosion. The supply was so much increased by this scraping that, even without the extensions in progress, it is now almost satisfactory.

Purification of Gas.

A PAPER by Mr. D. M. Nelson, read before the Scottish Gas-Lighting Association and printed in *The Gas World* (August 7), on the best and most economical means of purifying gas, did not appear to be wholly convincing to those who list-

ened to it. In the discussion elicited by the paper, it was handled rather severely. The burden of the paper was an attempt to prove the superior value of lime used in conjunction with oxid of iron to that of lime used exclusively, as a means of purifying illuminating gas. Mr. Nelson maintained that neither of these substances is in itself a complete purifier; but he claims that, taken together, they combine all the elements necessary to complete an economical purification. It was, however, intimated that much care in the selection of the bog ore is required, as well as in its treatment, to secure the most approved results. For example, it had been found that a cargo of uniform quality distributed among half a dozen different gas works in the same district did not, by any means, give like results either in economy, or in quality of gas, although similar mixtures of coal were used. The differences are partly accounted for by differences in local conditions, but long study and experience point to the conclusion that individual skill is a large factor. The difficulty in disposing of the spent lime in gas works has much increased. Owing to improvements in gas manufacture, spent lime no longer has the value as a fertilizer it once had, and is not now in demand for agricultural purposes; it has become substantially a waste product. Farmers will not accept it as a gift. On the other hand, oxid of iron, after its use as a purifier, is, on account of the chemical substances with which it is charged, a valuable article of commerce, in active demand. It is shown that, acting successively, these two materials much more effectively purify the gas than either used by itself, and also that three purifiers may be worked to great advantage where four are not practicable; but five are preferable,—No. 1, a catch purifier containing oxid, receiving the gas first, and passing it on to No. 2, also containing oxid, while the third, fourth, and fifth of the series contain lime. The powerful action of the oxid saves the lime, which, having much less to do in the process, is not so soon spent, and the quantity of spent lime is largely decreased. Revivification of the oxid is effected by simple exposure to the air for a sufficient period. It also takes a considerable time to so load it with impurities that it can be sold as a commercial article. In conclusion, it is said that, by the use of the oxid in the manner indicated, the cost of purification has been lowered from two pence per thousand cubic feet to three-fourths of a farthing. In the discussion which followed, however, it was maintained that two pence per thousand cubic feet was an exorbitant price for purification by the old method, and that the statement of economy based upon such an estimate was entirely unfair. The reduction in cost is also chargeable to a six-per-cent. reduction in the illuminating power of the gas, which, at the same price for gas, comes out of the pockets of consumers. It was also intimated that some managers of gas works who have adopted oxid purification would be glad to go back to lime, if they could. It appeared, also, to be the opinion of the meeting, as well as of the author, that ashes may be used in the catch-purifier as a sufficient substitute for the oxid.

Natural Ventilation.

THE subject of forced draught in buildings has been treated extensively of late in architectural and building publications, and in newspapers exclusively devoted to the interests of the heating and ventilating business. The fact that in very many cases artificial ventilation is, for numerous reasons, impracticable, and that in such cases the natural draft of ventilating flues must be relied upon for the removal of foul and the supply of fresh air, seems almost lost sight of among the flood of current periodical literature devoted to the discussion of ventilation. Perhaps this should be neither wondered at or criticized. The tendency of modern building has been increasingly toward structures of a class which, if systematically ventilated at all, must employ some means of effecting an artificial circulation. The importance of forced ventilation, and its availability as a general method, have been much enhanced during the last twenty years. At the same time,

buildings to which this system cannot be applied are, like the poor, "always with us," and they present ever-varying problems to be solved, and difficulties to be overcome. It is, therefore, with pleasure that we perceive the discussion of this subject renewed, so to speak, in an excellent engineering contemporary, *The Canadian Engineer* (August). We observe, however, that the writer of the article, "Natural Ventilation," includes in his discussion wind-driven devices for application to the out-door ends of ventilating flues for creating a draft, which are, strictly speaking, mechanical methods, as much as interior fans, driven by steam, gas-engines, or electric motors. Speaking of the difficulty (impossibility, we should call it) of obtaining anything like uniform natural ventilation for both warm and cold weather, the author, Mr. W. M. Watson, does not seem to emphasize the fact that neither very cold or very warm weather presents the maximum difficulty. The most imperfect natural ventilation is in medium weather,—too cool to permit the free opening of windows and doors, yet too warm for the maintenance of full fires in furnaces. In cold weather, in a house supplied with a warm-air furnace, and with a well-arranged system of ventilating flues, very good ventilation may be secured. In warm weather, when the fires are out, the open windows and doors supply ample admission and outflow of air; but on a chill day the doors and windows may be closed without a rekindling of the fires, and then ventilation is liable to be extremely defective. However, the cases that will not admit of artificial ventilation at small expense have of late been greatly reduced in number by the introduction of small, cheap motors. One of the greatest benefits to mankind resulting from the modern use of electric motors is the possibility of securing by this means good ventilation at times and in situations where effective ventilation would otherwise be impossible. Mr. Watson adopts the view that fresh air, in natural systems of ventilation, should be brought in at the ceiling; he also seems to think that outlets for impure air should be about at the same level, basing his views upon experiments which he does not authoritatively quote, but which he assumes to have settled a much-disputed question.

Theory and Practice in Trade Teaching.

SIR PHILIP MAGNUS recently delivered an address before the Society of Arts, section "A" (reported in the *Journal of the Society of Arts*, July 9), in which he states that the institution of trade schools, and the advances which have been made in technical instruction, have supplied material for a new chapter in pedagogy, which is yet to be written, and which may at any time be added to the science of education. The principal way that technical training for any trade is best learned is actual practice in the factory or shop. In the trade schools this method has been adopted and adhered to. Difficulties have arisen in carrying it out. One difficulty pointed out is the exact indication of the kind of theory which ought to be taught in the trade schools in conjunction with practical work. There are those who criticise the courses of instruction in use in the English trade schools, and think them ill-adapted to the purpose in view. The author of the paper says that the fact that thousands of workers, in some of the largest and most important industries, are not reached by instruction in the trade schools was brought prominently to his notice some time since, when he was requested to ascertain what proportion of the candidates at the technological examinations succeeded in qualifying for full certificates by passing in certain allied branches of science in science and art departments. He found that less than seventeen per cent. of the successful candidates were so qualified, and in some of the industries the proportion was much smaller. In a very interesting paper, which all who are interested in trade schools would do well to read, he discusses what he calls the "methodology" of trade teaching, going rapidly over the subject, throwing out suggestions, and indicating some of the difficulties involved.

THE CONTINENTAL PRESS

The New House of the German Engineers.

WE have already noticed the completion of the new building in Paris for the *Société des Ingénieurs Civils de France*, and now comes an account of the handsome new home of the *Verein Deutscher Ingenieure* in Berlin, the dedication ceremonies of which are given in the *Zeitschr. d. Ver. deutscher Ing.* for June 26. The building which is now completed has been under consideration for more than three years, and, as the result of a competition, the plans of Messrs. Reimer and Korte were accepted and the corner stone laid in April of last year. The design, which is the renaissance school, is well adapted for the purposes of the society, and, while the general effect of the structure is simple, the walls are relieved by several sculptured tablets typical of the character of the organization. Upon the upper wall, above the carved name of the society, in high relief, appear two seated figures, representing Theory and Practice, while below, on a bracket backed by a carved medallion, is a fine bronze bust of the late Professor Grashof, a replica of the portrait bust which adorns his monument at Carlsrühe. The two lower floors of the building are arranged to be let as offices, thus constituting a source of income, while above these are the rooms for the work of the society, including handsome editorial quarters for the publication of the journal of the society, together with business- and meeting-rooms and the library. The corridors are handsomely finished with marble and oak, and the building is warmed with hot water and lighted with electricity and gas. The entire cost of the structure was $90,000, of which $50,000 is held by the Deutsche Bank on mortgage at 4½ per cent. Both in the architectural and financial management of the work the society has shown excellent judgment and skill and the result of the efforts of the management is a building which, both as a home for the society and as a commercial investment, represents success of the first order.

Inland Waterways in Germany.

AT the present time there appears to be a general interest in central Europe in the development of inland water communication, especially in connection with the opening of waterways connecting southern Germany and Austro-Hungary with the rivers emptying into the North sea. The convention of the German-Austrian-Hungarian Association for Inland Navigation, recently held at Vienna, was the occasion discussion of the important plans which have been under consideration for several years; and of a report of the proceedings in the July issue of the *Oesterr. Monatschr. für den öffent. Baudienst* we give the following abstract:

The three important projects brought before the convention were the Danube-Oder canal, the Danube-Moldau-Elbe canal, and the Danube-Main canal. The first of these is of importance principally because of the outlet it would give to the Prussian and Saxon coal fields. The difficulties involved in its construction, however, and the expense of operation, rendered the project one of doubtful value in the opinion of the convention, although its favorable consideration was urged from Dresden.

The Danube-Moldau-Elbe canal has already been reviewed in these pages in connection with the competitive plans of the various engineers, and it appears decidedly the best of the three plans for connecting the Danube with the North sea. True, many difficulties lie in the way of its successful completion, and engineers are by no means united as to the best method of overcoming the differences of elevation, opinion being divided as to the relative merits of inclined planes, lock, or hydraulic lifts. The principal points discussed at Vienna for this scheme were of a financial nature, and it is doubtless the question of cost and possible income which will govern the choice of plan and route in any case.

The proposed Danube-Main canal is more especially a Bavarian idea, as the

canal itself would be in that kingdom, although its construction would also involve the canalization of the upper Main to Aschaffenburg. A decided opposition to the canal is manifested by the agricultural portion of the population, based on the feeling that communication with the eastern grain fields will injure the market for home products. It is by no means certain that this will influence the actual decision, although it is not without political importance.

In spite of the success of those hydraulic canal lifts thus far constructed, there seemed to be a decided preference at the convention for the old-fashioned lock system for overcoming differences of elevation. The more recent idea of inclined planes with ship railways is regarded somewhat doubtfully, and the plans of Lanna & Vering for the Danube-Moldau-Elbe canal are most favorably regarded, because they include only locks, instead of the more mechanical devices.

There is every evidence that both southern and Northern Germany, as well as Austro-Hungary, are all earnestly seeking some satisfactory system of internal waterways which will permit freer and cheaper intercourse for merchandise, especially in connection with the handling of coal and grain; and in this latter commodity the construction of any one of the proposed canals could not be without effect in increasing the competition between the product of the Hungarian wheat country and the American grain.

Electro-Chemistry in Germany.

In most of the branches of applied electricity progress has been at least as rapid in the United States as in Europe, frequently because there is less opposition on the part of conservative prejudices in the newer country than in the older ones. In the department of electro-chemistry, however, Germany has taken the lead in many ways, and the proceedings of the fourth convention of the German Society of Electro-chemistry, held at Munich in June, and reported in the issues of the *Zeitschrift für Electrochemie* for July 5 and 20, contain much of value and interest not only to professional chemists, but also to those engaged in the commercial and industrial side of the art.

The development of dynamic electricity, so-called, or the production of electricity from power rather than from chemical action, has to a great extent reversed the old idea, and, instead of generating the current from chemical action, the mechanically-produced current is used to effect many chemical reactions in a much simpler and more effective manner than has otherwise been possible.

Leaving out of consideration the revolution which has been wrought in chemistry by the use of the electric furnace, many important simplifications have been effected by the use of the electric current in dialyzing and in capillary reactions.

The action of the current in decomposing compounds and producing new combinations has also been found of great service, while in many departments of both qualitative and quantitative analysis the ever ready electric current has been pressed into most efficient service.

In all these developments the German chemists have been most active, and, among the names of those who have advanced this branch of science, those of Borchers, Nernst, Liebenow, and many others may be mentioned.

At the Munich convention valuable papers were read upon the electric furnace, upon electro-capillary action, upon electro-chemical synthesis, and upon many other problems, including the generation of the current from direct combustion of carbon; and the number of those who took part in the discussions, and the general interest developed, showed that the questions possessed a technical and commercial interest of immediate importance and value.

The whole subject of electro-chemistry is one which should be given active and energetic study in all industrial establishments, and, until other countries attack the problems with the activity now shown in Germany, they must be content to remain followers in this important department of applied science.

The Diesel Motor.

AMONG the papers presented at the recent convention of the German Society of Mechanical Engineers of Cassel, one of the most interesting was the description, by Herr Rudolf Diesel, of the improved motor which he calls a "rational heat motor."

Herr Diesel has approached the problem of the economical generation of power from combustible material in so intelligent a manner, and his efforts have resulted in the production of a machine so extraordinary in efficiency, that we are certain that the Diesel motor will attract much attention from all who are interested in the economical production of power.

From an account in the *Zeitschr. des Ver. deutscher Ingenieure* for July 10 and 17, we abstract the following description, strongly recommending those interested in the subject to examine the matter fully.

Herr Diesel began by examining the question theoretically, and practically formulated his plans before the motor was designed at all; and his account of his work forms an admirable example of the modern methods of scientific investigation as compared with the old "cut and try" schemes of earlier inventors.

The motor is constructed along the lines of existing gas and petroleum engines, but differs from them radically. There is no explosion, but instead a definite combustion, and the fuel may be gas, oil, or powdered coal. The fuel charge is not drawn into the cylinder with the air and there compressed with it; the air is given a preliminary compression, in two stages, to a much higher degree than is customary, reaching five hundred pounds to the square inch. The final stage of this compression is attained in the first working cylinder, when the fuel is admitted, and is at once ignited by the heat of compression, no special igniting device being necessary. The combustion produces an increase of pressure which impels the piston, and at the end of the stroke the gases expand still further in a second cylinder, after which they are discharged into the air.

The general arrangement of the machine is as follows: Two vertical cylinders have between them a third larger cylinder. All three pistons are connected to one crank shaft, the smaller ones having coincident cranks and the larger one being at 180° from the other two. The large cylinder is double-acting, with stuffing box; the smaller ones have plungers. The lower end of the large cylinder acts as a preliminary air-compressor, feeding into a reservoir from which the smaller cylinders draw. The first small cylinder draws air from the reservoir, and compresses it to a point where it is hot enough to ignite the incoming petroleum, or gas. The fuel is forced into the cylinder, combustion takes place, and a power stroke is made. The exhaust is then made into the upper end of the larger middle cylinder, which acts as a low-pressure cylinder of a compound system, after which exhaust into the air is made. The second small cylinder acts precisely as the first, except that it is compressing when the first is making a power stroke, and *vice versa*. The small cylinders make power strokes every other revolution, while the low-pressure cylinder makes a power stroke every revolution.

The main points of difference between this motor and existing petroleum or gas engines are the following: The very high degree of compression insures a rapid and thorough combustion and a higher upper limit of temperature than is otherwise attainable. Also, the fuel is burned gradually and not explosively, as the indicator cards show, and the combustion can be cut off almost as sharply and definitely as the pressure in a steam engine. The high-pressure gases are fully expanded in two cylinders to such an extent as to abstract nearly all the effective energy, so that the exhaust is quiet in operation, without that barking puff which makes the whereabouts of a gas engine in operation usually so easily recognizable.

The use of the high temperature of compression to insure the ignition results in few failures of ignition, and the gradual combustion maintains the high temperature in the cylinders during the continuous operation of the motor.

The Diesel motor has been very thoroughly tested by a number of able and disinterested experts. During the present year tests have been made at the Otto Gas Engine works at Deutz, at the Sulzer Engine Works at Winterthur, by Prof. Sauvage at Paris, and by Prof. Schröter at the Technical High School at Munich.

Prof. Schröter gives a very full report of his test in the *Zeitschr. des Ver. deutscher Ingenieure* for July 24, and shows that with a Diesel motor built by the Augsburg Machine Works, operated with ordinary American petroleum, an efficiency of 34.2 per cent. indicated power was obtained when working at full load of about 20 h. p., and that an efficiency of 38.5 per cent was obtained when operating under a load of about 10 h. p.

When it is remembered that 12 to 13 per cent. is the highest that can be obtained from triple-expansion steam engines in units of about 1,000 h. p., and that 20 to 23 per cent. is excellent for existing gas engines, the step in advance which Herr Diesel has made with this little 20-h. p. motor must be regarded as noteworthy indeed.

Air-Compressor Explosions.

EXPLOSIONS of receivers containing compressed air are by no means common; indeed, it is generally supposed that air under the moderate pressures used in mining and other operations is practically free from danger of explosion. Several cases, however, have been noted in which dangerous, and even fatal, explosions have occurred. In the issue of *Glückauf* for June 26 is given a very full account of a fatal explosion which occurred some months ago at Dortmund. The violence of the explosion was remarkable, the building being destroyed and the engineer killed, while a fragment of the receiver weighing nearly four tons was thrown over a building nearly 100 feet high, much other damage being done.

The result of the investigation showed that the explosion could not have been due merely to the expansive force of the air in the receiver, since at no time did the pressure exceed 80 pounds to the square inch, there being two safety valves weighted to about 75 pounds on the receiver. The compressor itself was of the well-known Burckhardt type, built by the Duisburg works, and all parts appear to have been of ample strength. The cylinder walls and heads were water-cooled, but the valve chests, containing the slide air valves, were not jacketed. Lubrication was effected automatically, a high-grade cylinder oil, known as valvoline, being used.

At the time of the explosion a thick cloud of smoke rose from the place, and, as soon as the wreck was examined, the inner walls of the shattered cylinders and valve chests were found to be covered with a thick coating of finely-divided carbon, together with small particles of solid matter resembling coke.

These facts suggested the action of explosive gas mixtures, and the oil was subjected to chemical investigation, with the result of proving the lubricant to be a high-grade cylinder oil, igniting at 291° C. and boiling at 375° C., and free from volatile hydro-carbons. Like all organic substances, it was decomposed at red heat, giving off oil gas and leaving a residue of carbon; and 20 grams of the oil was then found sufficient to render one cubic meter of air violently explosive.

Under these conditions it appeared that the absence of water-jacketing on the slide valve chests might permit enough heat to be generated to convert a portion of the lubricant into gas, thus practically charging the entire apparatus with an explosive mixture, the explosive force of which would be greatly increased by the existence of the pressure, which equals that attained by compression in gas and petroleum explosion motors.

These deductions are warranted by other observations. At the "Bommerbanker" mine a slight explosion occurred last year, and, on opening the valve chest, a lining of carbon was found, containing particles of glowing coke. Also at the "Borussia" mine an explosion occurred in connection with a Riedler compound compressor, in December last, the ignition being caused

by the approach of a lamp to the valve chest, and the flame being drawn in with the air suction. In a compressor of this design, however, it is hardly possible for the vapor to ignite itself, since the compression is effected in two stages, and the air very thoroughly cooled in both cylinders.

It is very evident from these experiences that, even with the best lubricants, it is important that all parts of an air-compressor should be thoroughly cooled, and that the mere cooling of the cylinders is not sufficient to prevent either the formation of explosive mixtures of air and hydrocarbon vapor, or the ignition of such mixtures when formed.

Questionable Economy of Water Power.

IN view of the frequent discussion at various assemblages of engineers as to the actual cost of power derived from various sources, the state of affairs in France, as brought out in an article in the *Moniteur Industriel* for July 3, may prove of interest.

It is often assumed that water power is vastly more economical than any artificial source of energy, since it is furnished gratuitously, so to speak, by nature. As a matter of fact, however, the cost of installation, including the acquirement of water rights and the construction of plant, often brings the fixed charges to a point where the economy over artificial power becomes doubtful. This is especially the case when the supply of water is variable and the demand for power constant, as a reserve engine then becomes necessary, and expense is added to inconvenience.

The fact is that water power is not a natural source, any more than coal, for instance, both having their origin in the processes of nature, but both requiring conversion by highly-organized mechanical methods before they can be regarded as power at all in the commercial sense.

In France, as the article referred to shows, the result of expert investigation, in the course of certain law suits about water rights, has demonstrated that, for purposes demanding uniform and constant power, there is little or no economy in the use of water power.

Decisions by the highest courts have apparently been to the effect that the reverse is true, and, as a result, there is now in France a lively discussion as to the relative value of expert and judicial opinions. At the same time, there seems to be little doubt that a high economy is realized with water power only when there is an ample supply under those natural conditions which render the original cost of installation a minimum, and the expenses of maintenance low. Many cases of this sort occur in Switzerland, and there are numerous examples in the United States, but it should always be remembered that "cost" is a very elastic term, and that it should, in honesty, be made to include, for interest, repairs, depreciation, and other fixed charges, an amount properly representing the true cost in comparison with other sources of power.

The high economy now attainable with various forms of internal-combustion motors, and the cheapness with which fuel gas can be produced from low-grade combustibles for use in such motors, should render such sources of power a subject for thoughtful consideration in comparing the so-called "natural" sources of power with artificial methods; local conditions will often decide against the natural, and in favor of the artificial, power.

The Liernur Sewage System at Trouville.

THE Liernur pneumatic system for the removal of sewage has been in operation for more than twenty-five years in Amsterdam and Leyden, and its success in those older installations has led to its introduction in other cities, especially where the fall has been found insufficient for effective gravity water drainage.

The latest application of the method is that just completed at the well-known watering-place, Trouville, of which a description is given in *La Revue Technique* for July 25.

The Liernur system differs from all gravity systems in that the sewage is removed entirely by atmospheric pressure. The discharges from each house are de-

livered into an air-tight metal reservoir, from which they are in turn drawn by suction into larger collecting tanks, these latter delivering the matter to an out-of-town works, where all the refuse is converted into an inoffensive fertilizer. It will thus be seen that the house service is entirely distinct from the storm water drainage. By thus removing all the sewage in air-tight metal pipes, the highest degree of sanitary excellence is obtained.

Since its introduction in the early seventies, the pneumatic method of Captain Liernur was extended in Amsterdam, until at the end of 1895 the area served contained nearly 85,000 inhabitants, while the military quarter of St. Petersburg, the entire city of Riga, and a number of other places, have been provided with the system.

Trouville is especially well adapted for the successful installation of the method, and the location also makes the application of any satisfactory gravity system impracticable. For the Liernur plant there are provided eleven main collecting tanks, each of these being at the lowest point of the district which it drains. With these tanks, which are air-tight shells, all the delivery pipes from the houses connect, while one main collecting pipe runs from the tanks to the poudrette factory. A powerful suction air-pump at the factory makes it possible to produce a vacuum in the system, and once a day the entire system is exhausted. The valves on the connecting pipes between the houses and the tanks being closed, a vacuum is produced in the latter, and, connection with the pump then being shut off, the rapid opening of the house connections causes an immediate and entire clearing of all the house tanks into the vacuum tanks. The house connections are again closed, and the vacuum tank exhausted into the main leading to the factory, air being admitted by a special valve to permit the flow to take place. The entire operation is the work of one man, who makes the tour of the town in about four hours, his only labor being the opening and closing of the valves, the pump at the works being kept in constant operation during the time.

The manufacture of the poudrette being conducted at a proper distance from the city, there is nothing to give offence; all the tanks are underground, the valves being operated from connections at the surface in the streets.

Owing to the manner in which the material is collected, its conversion into fertilizer is commercially possible so as to yield a considerable revenue, and at Trouville, where the population during the season reaches 20,000, it is estimated that the receipts from the sale of poudrette will furnish a material income over and above all operating expenses.

As the practical value of the Liernur system has been a subject of discussion among sanitary engineers for a number of years, this new installation will be watched with interest, especially in view of the importance of the place where it has been introduced.

Explosions in Mines.

THE fact that the production of firedamp in coal mines bears a relation to atmospheric conditions is well known, and it has been the practice in Germany for several years to keep a record of the variations in barometric pressure in connection with the explosions in coal mines, in order to investigate the subject.

The issue of *Glückauf* for August 7 contains the report for 1896 for the Dortmund mining district, with a very instructive diagram of the variations in atmospheric pressure for each month, as observed at Dortmund and at Essen, with the explosions of the year indicated at the day and hour of occurrence.

From a number of investigations the following laws have been deduced for the relation of gas production and atmospheric pressure.

As a rule, the proportion of gas in the air of mines diminishes with increasing atmospheric pressure, and increases with diminishing pressure.

The volume of gas increases the more rapidly the quicker the barometric curve falls, and *vice versa*.

If, after a rapid rise in the barometric curve, the pressure increases much less

rapidly, or comes to a standstill after a maximum has been attained, a slow increase in the volume of gas appears; while, if, after a rapid fall in the barometer, the pressure becomes stationary, there follows a slow diminution in the volume of gas present. It therefore appears that the maximum and minimum points of barometric pressure do not always correspond to the minimum and maximum points of the gas curve.

The report for the last year contributes some interesting data upon the subject, and confirms in many points the above laws. In a total of 42 explosions, 27 or 64 per cent., occurred during low atmospheric pressures or periods of rapidly-falling barometer, while 15 explosions, or 36 per cent., took place at other times. During the six years that these records have been kept in the Dortmund district the proportion of explosions occurring at periods of low barometric pressure has been about 60 per cent., and, while this is hardly enough to permit predictions or warnings to be made with much confidence, it is believed that the connection is sufficiently important to warrant further investigation.

An examination of the chart is more convincing. Thus, in January, 1896, a period of low pressure occurred between the 13th and 16th of the month, during which time four disastrous explosions took place in as many different mines. Again, in the middle of November, during a fall of nearly 20 mm. in pressure, six explosions occurred, and, in general, the grouping of the disasters upon the plotted barometer-curves shows a relation much more definite than is deduced from the tabular averages. Similar charts might readily be produced in the United States from the barograph records of the weather bureau, without requiring any additional observations, and it is possible that, by extending the investigations over a wider area, more definite conclusions might be reached.

The Electric Traction of Boats.

THE application of mechanical traction to the haulage of boats on canals and rivers has been made as yet only in a few instances, the use of animals being in many cases found to be more economical under the peculiar conditions of the service. Attempts are now being made in France to introduce electric traction, and in *La Revue Technique* for July 25 an account is given of the systems of MM. Denèfle & Co., which seem thus far to have given encouraging results.

Two methods have been applied, of which only the first can properly be called a traction system. In this method a so-called "electric horse" is employed, the novel animal being a sort of electrically-propelled tricycle, constructed somewhat like a traction engine, but propelled by electric motors, and taking its current from an overhead trolley wire. No track is required, the machine travelling along the tow path, and hauling the boats by means of a tow rope. The motorman rides in a sort of cab, and not only directs the propelling apparatus, but also steers the machine.

The overhead wire is carried over the middle of the tow path upon supports much like those used for tramway purposes, the poles being upon but one side of the path and the wire being carried on overhanging brackets. The trolley pole is free to follow the line of the wire to a sufficient extent to maintain its contact even should the machine not keep exactly in the middle of the road, and, so far as mechanical performance is concerned, the whole apparatus seems to work very well.

The second method described is rather a propelling device, and consists of an electrically-operated screw propeller, which may be attached to any existing canal boat. This device is ingenious, as it is entirely contained in the rudder, which is formed of a sheet-iron box, in which is placed an electric motor operating a screw propeller projecting from the end of the rudder.

The current is conveyed to the motor by means of wires, as usual, the entire working machinery, with the exception of the propeller itself, being enclosed water-tight, in the rudder. The connections are carried down through the rudder

post, and it is a matter of only a few minutes to unship the common rudder and substitute one of the propelling ones upon any canal boat.

As in the previous case, the current is taken from a trolley wire carried along the tow path, the boat being provided with a trolley pole for the purpose.

The greatest element of merit in these devices lies in the fact that absolutely no change is required in the construction of existing boats; nor are any new motor boats required. At the same time the systems involve the construction of power houses and the erection and maintenance of trolley wires.

A thorough test of electric traction is to be made on the canals of the Aire and the Deule, between Marles and Pont-à-Vendin, under exceptionally favorable conditions, and, should the economy of this form of power traction compare favorably with animal power, in point of economy, the system doubtless will be extended throughout France and elsewhere.

Electric Plows.

ELECTRIC traction has been applied to the operation of plows, both in France and Germany, for the past two years, and the results of the apparatus, as improved by experience, are sufficiently satisfactory to warrant the introduction of electrically-propelled plows as a commercial product.

The latest form of apparatus is described in *Die Elektrizität* for July 17 and 31, from which some interesting details may be abstracted. The general principle is practically the same as that of other power-propelled plows, a gang plow being hauled back and forth across the field. The electric motor is carried on the plow itself, and drives a pocketed chain sheave, which engages with a chain stretched across the field and anchored at each end. The current is conveyed to the motor through a pair of trolley wires supported on carriers, which may be moved laterally across the field as the work progresses. Where no other source of current is available, a portable dynamo is provided, driven by an ordinary agricultural portable engine, and, since the current may be transmitted any reasonable distance without difficulty, the engine may be placed near a convenient water-supply, thus avoiding the necessity of carrying feed-water. When electric current from a general station is to be had, the use of electric plows offers numerous advantages. Current which is used for lighting by night can be fully utilized in the motors by day, and the introduction of a number of electric plows might make the installation of an electric plant profitable in sections where otherwise the demand for current might scarcely warrant the outlay.

The general advantages of power-plowing, and the localities in which the use of power is commercially profitable, have been well investigated already, in connection with the use of steam plows. Electricity adds principally the general advantage of power transmission from any convenient point, and does away with the necessity of having the entire power plant in the field where the work is to be done, and, in time, its wider introduction may lead to the establishment of agricultural power stations furnishing current not only for plowing, but for all the manifold purposes required in farming. Installations which at present are too expensive for any but the great landed proprietors may thus, by combination, be brought within the reach of many smaller farmers.

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Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
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Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
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Architektonische Rundschau. *m.* Stuttgart.
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Bankers' Magazine. *m.* New York.
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Bankers' Magazine of Australia. *m.* Melbourne.
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Board of Trade Journal. *m.* London.
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Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
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Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
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Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, Eng.
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Génie Civil. *w.* Paris.
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Glasers Ann. für Gewerbe & Bauwesen. *s-m.* Berlin.
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Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
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Iron & Steel Trades' Journal. *w.* London.
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Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
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Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
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Kansas University Quarterly. *qr.* Lawrence, Kan.
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Master Steam Fitter. *m.* Chicago, Ill.
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Metal Worker. *w.* New York.
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Moniteur des Architectes. *m.* Paris.
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Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* Vienna.
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Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Révue Technique. *b-m.* Paris.
Safety Valve. *m.* New York.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweitzerisches Bauwesen. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York
Scientific Machinist. *s-m.* Cleveland, O
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Stationary Engineer. *m.* Chicago, Ill.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technic. *yr.* Univ. of Mich.
Technology Quarterly. Boston, Mass.
Tradesman. *s-m.* Chattanooga, Tenn
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterr. Ing. und Arch. Ver. *w.* Vienna.
Zeitschrift des Ver. Deutscher Ingenieure. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Barracks.

The Archduke Frederick Barracks and Military Hospital at Teschen. (Die Erzherzog Friedrich Kaserne und das Truppen Spital in Teschen.) With photographic views and plates of details of these important buildings. 2500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14731 D.

Century Building.

The Century Building, St. Louis. An illustrated detailed description of a marble palace for business and amusement. Contains stores, offices and a theatre. 8000 w. In Arch, Aug., 1897. No. 14926 G.

Dock Warehouses.

See same title under Marine Engineering.

Fire-proofing.

Details of Fire-proof Construction with Burned Clay. Peter B. Wight. A study of column protection. Ill. 2500 w. Br Build—Aug., 1897. No. 14944 C.

Foundations.

Foundation for the Canal & Claiborne Electric Railway Power House, New Orleans, La. Illustrated description of a building foundation on soft ground presenting features of interest. 600 w. Eng News—Aug. 19, 1897. No. 16800.

Hospitals.

Cottage Hospitals. Thomas W. Aldwinckle. History of this movement as given in a book by Henry C. Burdette, dealing also with the architecture. 4700 w. Jour Roy Inst of Brit Arch—July 29, 1897. No. 14652 A.

Library Building.

The New Massachusetts State Library Building, at Boston, Mass. Brief illustrated description of the new extension to the Massachusetts State Capitol. 1500 w. Sci Am Sup—Aug. 28, 1897. No. 14864.

HEATING AND VENTILATION.

Churches.

Heating and Ventilating Churches. An instructive chapter, reprinted from book by George W. Kramer, touching on the essential features. 6000 w. Met Work—Aug. 21, 1897. No. 14812.

Court House.

Heating and Ventilation of the Jefferson County Court House, Louisville, Ky. Illustrated description of building heated by the fan system. 800 w. Heat & Ven—Aug. 15, 1897. No. 14661.

Exhaust Steam.

Utilization of Exhaust Steam. George L. Thayer. Read before the Northwestern Electrical Assn. Describes the earliest attempts at central station heating, the difficulties met, and improvements made, the different systems, condensation, and related matters. 2000 w. W Elec—July 31, 1897. No. 14429.

See same title under Electrical Engineering, Power.

Hot Water.

A Hot Water Heating System for Single Floors. (Beschreibungeiner Etagen-Warm Wasser Heizung.) Describing a system for warming apartments by water heated from the kitchen range; as applied in Italy. 2500 w. Gesundheits Ingenieur—July 31, 1897. No. 14782 B.

Normal School.

Warming and Ventilation of the State Normal School Building, Salem, Mass. Illustrated description. The specially interesting features are in the compactness of the systems of air ways, and in the resulting economy of floor and room space; in the reduced cost and methods for the economizing of heat. 2300 w. Eng Rec—Aug. 21, 1897. No. 14831.

Residence.

Combination Heating System in a Philadelphia Residence. Illustrated description of successful installation at the residence of T. Henry Asbury, Oak Lane. 500 w. Heat & Ven—Aug. 15, 1897. No. 14662.

Steam Fitting.

Steam Fitting. James F. Hobart. Part first discusses the handling of pipe, straightening of bent pipe, cutting-off, &c. Ill. 1500 w. Dom Engng—Aug., 1897. Serial. 1st part. No. 14854 C.

Ventilation.

Natural Ventilation. W. M. Watson. Suggests systems of ventilating not covered by patents, and discusses methods that have been found satisfactory. Ill. 2400 w. Can Eng—Aug., 1897. No. 14551.

The Mortier Ventilator. (Der Mortier Ventilator Anlager der Zeche Alma.) A powerful fan ventilator and steam plant recently erected at the Alma mine at Gelsenkirchen. With plate showing general arrangement. 1000 w. Glückauf—July 24, 1897. No. 14741 B.

The Purification of Basements and Arrangement of Ground Ventilation. (Die Reinigung des Untergrundes und Einrichtung einer Boden ventilations-anlage.) Discussing the importance of proper ventilation of basements as well as the surrounding soil, both from considerations of health and safety. 2500 w. Gesundheits Ingenieur—July 31, 1897. No. 14783 B.

LANDSCAPE GARDENING.

Difficulties.

Planting for the Future. H. A. Caparn. The lack of appreciation of the landscape gardener's work, due to defective imagination in the clients. 900 w. Gar & For—Aug. 11, 1897. No. 14575.

Private Grounds.

The Planting of Private Grounds. Editorial calling attention to sins of omission and commission, such as the utilizing of natural forma-

tions in grounds, the grouping of stones and foliage, cutting out of trees and shrubs, the planting too much, &c. 1600 w. Gar & For—Aug. 25, 1897. No. 14867.

The Dalles.

The Dalles of the St. Croix, Wisconsin and Minnesota. Mary C. Robbins. A description of this region, 150 acres of which have been reserved as an interstate park, and the movement on foot to secure 1550 acres. 1800 w. Gar & For—Aug. 25, 1897. No. 14868.

Trees.

The Rejuvenescence of Old Trees. Editorial account of an attempt to save a white oak growing in the Arnold arboretum. The result was successful. Also general discussion of the subject. Ill. 1300 w. Gar & For—Aug. 11, 1897. No. 14574.

The Use of Trees and Shrubs with Leaves of Abnormal Colors. Editorial comment on the art of garden design so far as it relates to the selection of trees and shrubs for some peculiarity of form or color. 900 w. Gar & For—Aug 4, 1897. No. 14467.

PLUMBING AND GAS-FITTING.

Back Vent Connections.

How Back Vent Connections Must Be Made in New York City. James J. Lawler. Calls attention to a few special requirements not usually understood by plumbers. Ill. 1000 w. Dom Engng—Aug., 1897. No. 14852 C.

Baths.

Public Baths in Europe. Edward Mussey Hartwell. An account of the origin and history of the public bath-house movement in certain of the leading industrial countries of Europe, showing what the experiences of the cities teaches as to the best methods of locating, planning and maintaining baths for the people. Ill. 22500 w. Bul Dept of Labor—July, 1897. No. 14480 D.

Details.

The Great Importance of Perfection in Details in Sanitary Work. J. Kemsley. Read at the monthly meeting of the Institute of Sanitary Engineers. Gives examples of serious troubles caused by trifling matters, or what a little attention would remedy. 3000 w. Dom Engng—Aug., 1897. No. 14855 C.

Drains.

Examining and Testing Old Drains and Sanitary Appliances. T. E. Coleman. Reprint from a book received from Messrs. Spon & Chamberlain. Urges the periodical examination and testing as a matter of health and expense. Directions for testing are given. 2500 w. Dom Engng—Aug., 1897. No. 14853 C.

Police Station.

Plumbing in a Police Station. Illustrated description of the work in the Ninth Precinct Police Station-house, in Charles Street, New York City. 900 w. Eng Rec—Aug. 14, 1897. No. 14648.

Waste Closets.

Slop-Water Closets in England, Their Manufacture and Use. J. A. Turner. Describes what is meant by a slop-water closet and the advantages in its use over the ordinary fresh-water closet. Types illustrated. 1700 w. Brick—Aug., 1897. No. 14434.

Waste Water for Flushing Purposes. A. Edward Allen. Recommends the use of appliances for storing the slop and rain water for flushing. 1200 w. Ill Car & Build—Aug. 6, 1897. No. 14618 A.

MISCELLANY.

American Architecture.

A Hopeful View of American Architecture. Allen B. Pond. Calls attention to the awakened interest in architecture, and to the indications of improvement. The restrictions and difficulties are also discussed. 1600 w. In Arch—Aug., 1897. No. 14924 G.

Brownstones.

Brownstones. T. C. Hopkins. From Appendix to the Annual Report of Pennsylvania State College. Part first treats of their texture and microscopic features, and the causes of decay in the cities. Ill. 4500 w. Stone—Aug., 1897. Serial. 1st part. No. 14675 C.

Ceilings.

Decorated Ceilings. Walter J. Pearce. Considers the painted decoration. Ill. 1800 w. Plumb & Dec—Aug. 2, 1897. No. 14563 A.

Centennial Buildings.

Some Notes on Tennessee's Centennial. F. Hopkinson Smith Contains an account of the fine buildings, with illustrations by the author, and criticisms. 5000 w. Scribner's Mag—Sept., 1897. No. 14856 C.

Chimneys.

The Statical Computations for Tall Chimneys. (Die Statische Berechnung Grosser Schornsteine.) Discussing the conditions of stability of tall masonry chimneys under wind pressures. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14735 D.

Church.

St. Kavin's Church, Traumburg, Bohemia. Bertram G. Goodhue. Illustrated description. 2000 w. Arch Rev, Vol. IV, No. IV. Serial. 1st part. No. 14963 F.

Clay.

The Drying of Clay in Large Masses. (Ueber das Trocknen von Thon in Grössern Massen.) With a description of Toldt's new drying furnace, illustrated. 4500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 10, 1897. No. 14763 B.

Competitions.

The Competition for the Proposed New York Public Library. Jack Shingle. A criticism of the features of the competition for the design of this building, and the conditions governing them. 900 w. Arch & Build—Aug. 7, 1897. No. 14526.

The Mexican Federal Palace Competition. Order for the opening of an international competition for the design of the edifice destined to serve as the palace of the Federal legislative

power of the Mexican Republic. 2500 w. Arch, Lond—Aug. 6, 1897. No. 14646 A.

English Architecture.

Some Thoughts on Old English Architecture. E. Guy Dawber. Read before the Bristol and Gloucestershire Archaeological Society. Traces some of the methods and traditions of building in England, noting their bearing on its architecture particularly in the Cotswold country. 3000 w. Builder—Aug. 21, 1897. No. 14945 A.

Flooring.

Papyrolith and Other Artificial Flooring. Information of papyrolith, cork-stone, and Knoch's elastic flooring. 1200 w. Cons Repts—Aug., 1897. No. 14442 D.

The Schürmann Solid Floor Construction with Sheet Iron Keys. (Schürmann's Massivdecken auf Wellblechsienen.) The use of stamped sheet metal keys enables a practical arch construction to be built between beams without special arch bricks or tiles. 2000 w. Schweizerische Bauzeiting—Aug. 7, 1897. No. 14767 B.

The Wehler Floor Brick. (Der Wellenfalgziegel Patent Wehler.) An improved hollow tile for floor and ceiling filling in connection with iron girders. A peculiar lock joint is used. 2000 w. Zeitscher d Oesterr Ing und Arch Ver—Aug. 6, 1897. No. 14730 B.

Greek Architecture.

Grecian Orders of Architecture. Cyrus K. Porter. On the development of the architecture of the Dorians and Ionians. Ill. 6500 w. Stone Aug., 1897. No. 14674 C.

Heater.

The Junker Water Heater. (Junker's Schnell-Flüssigkeitserhitzer.) A modification of the Junker gas calorimeter for the heating of water for household purposes. 2500 w. Zeitschr d Ver deutschr Ing—Aug. 7, 1897. No. 14722 B.

Monument.

The Imperial Monument at the Schlossfreiheit at Berlin. (Das Kaiserdenkmal auf der Schlossfreiheit zu Berlin.) An illustrated description with views of details of the fine monument to the memory of the late Emperor William I, recently completed at Berlin. 3000 w. 1 plate. Oesterr Monaschr f d oeffent Baudienst—August, 1897. No. 14733 D.

Pantheon.

The Pantheon, Paris. Historical account of the building of this beautiful edifice, with some reference to its defects. 3000 w. Arch, Lond—Aug. 6, 1897. No. 14647 A.

Pine.

Investigations on the Influence of Wind Cracks upon the Strength of Pine Timber. (Untersuchung über den Einfluss des Blaudwerdens auf die Festigkeit von Kiefernholz.) A very thorough series of tests upon the strength of wind shaken timber, with numerous illustrations, made by the Royal testing laboratory at Berlin. 25000 w. Mitt aus d Konig tech Versuchsaustalten—Part I, 1897. No. 14757 F.

Stone.

Tests of Natural Stone. (Prüfung Natürlicher Gesteine.) A very full series of tables and data of the compressive strength of various kinds of stone, as well as resistance to wear; includes a variety of granites, sandstones and limestones. 18000 w. Mitt aus d Konig tech Versuchsaustalten—Part I, 1897. No. 14758 F.

Tarsney Act.

The Supervising Architect's Office Reorganized. The placing in force of the Tarsney Act by Secretary of the Treasury, with details for its enforcement. 4000 w. In Arch—Aug., 1897. No. 14925 G.

Tenements.

The Tenement House Reform in New York City. S. Parkes Cadman. Treats of recent legislation resulting in the improvement of the tenement districts of the city. 3600 w. Chau—Sept., 1897. No. 14960 C.

CIVIL ENGINEERING.

BRIDGES.

Bascule Bridge.

The Michigan Avenue Bascule Bridge, Buffalo. Illustrated description of bascule bridge with a differential rolling counterpoise, and its operation. 1800 w. Eng Rec—Aug. 21, 1897. No. 14827.

Coffer-Dam.

The Coffer-Dam Process for Piers. Charles Evan Fowler. Historical account of the development, with discussion of why the coffer-dam has gotten into disfavor, with directions that success instead of failure may result. Ill. 4000 w. Stone—Aug., 1897. No. 14673 C.

Drawbridge.

Michigan Street Drawbridge, Buffalo, N. Y. Illustrated description of a double hinged liftbridge presenting novel engineering features. 1500 w. Eng News—Aug. 19, 1897. No. 14801.

See same title under Railroad Affairs, Maintenance of Way.

The Hase Drawbridge System (Laufbrücke, System Josef Hase). Arranged especially to permit coal barrows to tip into open cars, and draw up to permit the passage of box cars. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 24, 1897. No. 14764 B.

Failure.

The Tarbes Bridge Failure. Particulars and illustration, from *Genie Civil*, making it appear that the cause of failure was due to the design. 700 w. Eng Rec—Aug. 21, 1897. No. 14829.

Foundations.

A New Method of Building Submerged Foundations. Describes a method devised by D. Jordan, with a view to expediting the construction and lessening the cost. Ill. 800 w. Sci Am—Aug. 14, 1897. No. 14568.

The Foundations of the East River Bridge,

New York. Illustrations and particulars showing the progress thus far made. 2200 w. Sci Am—Aug. 7, 1897. No. 14471.

Niagara Bridge.

Test of the New Niagara Bridge. Brief report of the test and its success. Ill. 400 w. Ry Age—Aug. 20, 1897. No. 14818.

Pin System.

American and English Bridges. Editorial discussion of why the pin system is used in America and the rivet connections in England. 1600 w. Eng, Lond—Aug. 13, 1897. No. 14833 A.

Stresses.

The Actual Stresses in Bridge Members. A brief account of the instruments used and methods of procedure followed by M. Rabut, in his interesting investigations of actual stresses in the various types of bridges in use on the Western Railway of France. 1200 w. Engng—Aug. 13, 1897. No. 14823. A.

Suspension Bridges.

Modern Suspension Bridges. (Hängebrücke der Neuzeit). A paper by Prof. Mehrtens, with numerous illustrations, and a discussion of the possibilities of the method with modern materials and construction. 10000 w. Stahl und Eisen—June 15, 1897. No. 14745 D.

Victoria Bridge.

The Victoria Jubilee Bridge at Montreal; Grand Trunk Railway. Illustrated description of the tubular bridge across the St. Lawrence at Montreal, and also of the truss span bridge that is to replace it. 3000 w. Eng News—Aug. 26, 1897. No. 14891.

CANALS, RIVERS AND HARBORS.

Bulkhead.

Delaware Avenue Bulkhead, Philadelphia. Description, with illustrations of the general features of the standard sections of timber and concrete work. 1600 w. Eng Rec—Aug. 21, 1897. No. 14828.

Canals.

New York's Canals and Commerce. Alex. R. Smith. The conception, construction, cost, purpose, traffic, improvement and management of the canals, and their effect upon New York's commerce. 4500 w. Sea—Aug. 26, 1897. No. 14882.

The Rebuilding of the Rhine-Marne, and Saar-Kohlen Canals. (Ueber die Reconstructions-Arbeiten am Rhein-Marne und Saar-Kohlen Canal.) Giving details of the new locks, aqueducts, tunnels and other improvement works on these important waterways of Alsace-Lorraine. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 6, 1897. No. 14729 B.

The Chicago Drainage Canal. Frank W. Skinner. Brief reference to the history and conditions that led to the construction of this canal, with statement of the plan and some account of the work. Ill. 3500 w. Eng, Lond—Aug. 6, 1897. Serial. 1st part. No. 14604 A.

The Ottawa Valley Canal. Andrew Bell. Discusses the difficulty of getting deep water on what is called the Lower Ottawa. 900 w. Can Eng—Aug., 1897. No. 14552.

Colombo Harbor.

Colombo Harbor. Editorial discussion of the advantages of this harbor, and of the railway scheme to connect the railway system of Ceylon with that of India. 1200 w. Eng, Lond—Aug. 20, 1897. No. 14935 A.

Dredger.

The Suction Pump Dredger "Octopus" for the Natal Government. Illustrated description. 700 w. Engng—Aug. 20, 1897. No. 14919 A.

Harbor Enterprise.

Harbor Enterprise in South America. Information from an article by R. W. Perks. The docks are described as the largest, newest and best equipped in the American continent. 1800 w. Trans—Aug. 6, 1897. No. 14631 A.

Saving a Town and Cape. George Ethelbert Walsh. Efforts to reduce the danger and prevalence of sand storms at Cape Cod, and to protect Provincetown. 1300 w. Sci Am—Aug. 21, 1897. No. 14670.

The Machinery Plant at the Harbor of La Plata. (Die Maschinenseinrichtung des Hafens von La Plata). Giving an account of the new warehouse plant, with basin, hydraulic cranes, &c., at Ensenada below Buenos Ayres on the La Plata, Argentina, with details of the pumps, accumulators and cranes. Two plates. 3500 w. Zeitschr d ver deutscher Ing—Aug. 7, 1897. No. 14720 B.

The Commercial and Winter Harbor on the Elbe at Riesa. (Der Verkehrs und Winter Hafen an der Elbe.) Description and plan of this important basin and quay wall. 1200 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1897. No. 14732 D.

Riparian Rights.

Riparian Rights in Underground Waters. The chief points of a paper by James Mansergh read before the Inst. of Civ. Engs. England, showing the injustice of the old English common law relating to underground waters, when applied to modern conditions, with editorial comment on similar affairs in the United States. 2700 w. Eng News—Aug. 19, 1897. No. 14699.

MISCELLANY.

Catenary.

The Stiffened Catenary. (Die Steife Kettenlinie.) A full analytical and graphical investigation of this most important problem in the subjects of combined resistance to bending and tension. 6000 w. Zeitschr d ver deutscher Ing—July 24, 1897. No. 14716 B.

Constructive Works.

The Paris International Exhibition of 1900. Notes of the preparations, the foundations of the buildings, especially the work for the new bridge over the Seine—the Pont Alexandre III. Ill. 2200 w. Engng—Aug. 20, 1897. No. 14917 A.

Convention.

Transactions of the Council of the Society of

German Engineers at the Cassel Convention. (Versammlung des Vorstandrates des Vereines Deutscher Ingenieure, in Cassel). With reports of committees and transaction of varied business. Two articles, 12000 w. Zeitschr d ver deutscher Ing—July 31, Aug. 7, 1897. No. 14723 E.

Engineering Works.

Notes of a Canadian Journey. Things seen and information collected by the writer, on a journey from Quebec to Duluth, via Halifax, Montreal and Chicago. 5500 w. Eng News—Aug. 26, 1897. Serial. 1st part. No. 14896.

Geodesy.

The Restoration of the Toise of Picard. (Restitution de la Toise de Picard). An interesting note giving the remeasurements of some ancient data in the Paris observatory, restoring the length of the toise of Picard, and making his geodetical measurements comparable with later work. 2500 w. Comptes Rendus—July 26, 1897. No. 14710 B.

Hero of Alexandria.

The First Engineer. W. A. Truesdell. An interesting account of Hero of Alexandria, his labors and their results. 6500 w. Jour Assn of Engng Soc—July, 1897. No. 14622 C.

Masonry Arches.

The Strength and Failure of Masonry Arches. Henry Harrison Suplee. Showing that the laws of elasticity hold good for masonry as for metallic structures. Ill. 3300 w. Eng Mag—Sept., 1897. No. 14898 B.

Steel Construction.

The Use of Steel in the Construction of Dams and Reservoirs. John S. Fielding. Considers steel as the proper material with which to construct a dam or reservoir and discusses the designs. Ill. 2800 w. Can Arch—Aug., 1897. No. 14844 C.

Stone.

See same title under Architecture and Building, Miscellany.

Surveying.

See same title under Mining and Metallurgy, Mining.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Amazon Exports.

Amazon India-Rubber Exports, First Half of 1897. Shipments from Pará and Manáos. Table. Ind Rub Wld—Aug. 10, 1897. No. 14678 D.

Brazil.

The Trade and Industry of Brazil. Statements regarding the exports, imports, productions, machinery, manufactures, &c. 2000 w. Bd of Trd Jour—Aug., 1897. No. 14878 A.

British Trade.

British Trade and the American Market. Considers the reasons for the outlook for British trade not being encouraging. 900 w. Bradstreet's—Aug. 28, 1897. No. 14910.

Consuls and Trade. Editorial discussion of the diplomatic and consular assistance required, and the suggestions made for the increase of trade. 1700 w. Engng—Aug. 20, 1897. No. 14920 A.

China.

The Promotion of Trade with China. Considers some of the suggestions made by Byron Brenan, for the promotion of trade. 2500 w. Engng—Aug. 13, 1897. No. 14825 A.

Concentration.

Industrial Centralization in Europe. Translation of an article by Henri Blancheville in the *Woolen Industry* of Paris. Calls attention to events occurring abroad, showing the tendency to consolidation, brought about by the necessities of the times. 1500 w. Cons Repts—Aug., 1897. No. 14444 D.

Credit Protection.

German Credit Associations. Explains the object of these associations and how it is accomplished, and gives general information of the system. 2500 w. Cons Repts—Aug., 1897. No. 14443 D.

Export Iron.

See same title under Mining and Metallurgy, Iron and Steel.

Import Duties.

The Dingley Law. Copy of the tariff act approved July 24, 1897. 47200 w. Bureau of Am Reps Bul. 75—July, 1897. No. 14441 D.

Industries.

The Distribution of Industries. A. Humboldt Sexton. Discusses the distribution of the various great industries over the United Kingdom, the conditions which determined their localization, and the probabilities of changes through the influence of changed conditions. 2500 w. Prac Eng—Aug. 13, 1897. No. 14850 A.

Japan.

The Foreign Trade of Japan in 1896. Information from the report drawn by Mr. Lay, acting vice-consul at Tokio, on the trade for 1896, showing a decided advance. 1800 w. Engng—July 30, 1897. No. 14507 A.

Panama.

Competition with British Trade at Panama. Reviews causes that tend to place the British manufacturer at a disadvantage, and comparing items of British origin with those of other countries. 1400 w. Bd of Trd Jour—Aug., 1897. No. 14877 A.

Prices.

A German View of Prices of Rubber Goods. From the "Gummi Zeitung." Thinks the only alternative is for manufacturers to estimate on higher selling-prices within the near future. 700 w. Ind Rub Wld—Aug. 10, 1897. No. 14676 D.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle, and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from July 1, 1892, to August 1, 1897, Covering the Period of Recent Extreme Depression. Table. Bradstreet's—Aug. 14, 1897. No. 14614.

Protection.

British Industries Developed by Protection. Historical review of legislation in England for the protection of manufactures. 4200 w. Bul of Am Ir & St Assn—Aug. 20, 1897. No. 14808.

Railroad Supplies.

The Railroads as Buyers of Supplies. Editorial summary of replies received from branches of the supply trade showing a fairly hopeful outlook. 2000 w. R R Gaz—Aug. 20, 1897. No. 14806.

Tariff.

Features of the New Tariff They Object To. Report of protests made by foreign countries to certain features of the new tariff. 600 w. Age of St—Aug. 7, 1897. No. 14500.

India-Rubber Goods in the New Tariff Law. A comparison with previous rates of duties. The rates are usually higher than under the law of 1894, but lower than under the McKinley law. 1000 w. Ind Rub Wld—Aug. 10, 1897. No. 15677 D.

New Customs Tariff of Canada. Schedules A, B, and C of the New Customs Tariff. 5000 w. Bd of Trd Jour—Aug., 1897. Serial. 1st part. No. 14879 A.

Tariff Changes and Customs Regulations. Sweden and Norway, Belgium, Netherlands, Germany, France, Portugal, Spain, Italy, United States, United States of Colombia, Venezuela, Morocco, British India, British Honduras, Barbadoes, and Montserrat. 4500 w. Bd of Trd Jour—Aug., 1897. No. 14880 A.

The New Metal Tariff. A copy of the new Canadian tariff affecting the iron and other metal trades, and including building material. 5000 w. Can Eng—Aug., 1897. No. 14554.

Trade Disputes.

First Proceedings under the Conciliation (Trade Disputes) Act. Comment on the report lately issued by the Board of Trade, with discussion of its utility. 1500 w. Jour Gas Lgt—Aug. 10, 1897. No. 14683 A.

World's Trade.

Twenty Years of Trade. Michael G. Mulhall. A survey of the world's trade for the past twenty years, comparing the growth of British commerce at decennial periods with that of other countries. 1400 w. Contemporary Rev—Aug., 7, 1897. No. 14588 D.

CURRENCY AND FINANCE.

Currency Reform.

Obstacles to Currency Reform. Carl Schurz. Considers the main obstacle to be cowardice of the politicians. 1600 w. Harper's Wk—Aug., 1897. No. 14425.

The Business Revival and Currency Reform. Evidences of reviving business and the probable effects on financial legislation are discussed. 1800 w. Banker's Mag, N. Y.—Aug., 1897. No. 14620 D.

Financial Situation.

A Review of the Financial Situation. Mentions the favorable conditions recently developed, and the many indications of activity and prosperity. 4000 w. Bankers' Mag, N. Y.—Aug., 1897. No. 14621 D.

Japan.

Japanese Industrial Finance. Editorial on an article in the *Japan Weekly Mail*, giving details of many of the most important proposals for the next few years, and making an interesting comparison of the financial condition of Japan with that of some of the leading European countries. 1800 w. Engng—Aug. 6, 1897. No. 14610 A.

LABOR.

Accidents.

Compensation for Accidents. Editorial on the effects of the Workmen's Compensation for Accidents Act. 1600 w. Eng, Lond—Aug. 20, 1897. No. 14936 A.

The Workmen's Compensation Act. Explanatory notes prepared by Thomas Ratcliffe Ellis. 9000 w. Col Guard—Aug. 20, 1897. No. 14931 A.

Capital and Labor.

Another Step in Promoting the Union of Capital and Labor. George Livesey. Read before the Incorporated Inst. of Gas Engs. In part first the present position is considered, and the advisability of making the worker a shareholder is discussed. The question is confined to the gas industry. 2800 w. Gas Engs Mag—Aug. 10, 1897. Serial. 1st part. No. 14859 A.

Eight-Hour Day.

The Struggle in the Engineering Industries. An appeal of the English employers to the general engineering industries of the country. 1200 w. Ir & Coal Trds Rev—July 30, 1897. No. 14522 A.

Electrical Regulations.

The Electrical Regulations of the Home Office. Editorial consideration of the Report of the Departmental Committee, for the protection of those engaged in the electrical industries. 3500 w. Elec Rev, Lond—July 30, 1897. No. 14511 A.

Strikes.

Lessons of the Great Engineering Strike in England. J. Stephen Jeans. Criticising the trade union attitude toward piece-work, apprentices, and machine tools. 4700 w. Eng Mag—Sept., 1897. No. 14897 B.

The Bituminous-Coal Strike. Some reference to the difficulties in the situation. 800 w. Bradstreet's—Aug. 28, 1897. No. 14909.

Unions.

Organization and Benefits of Trade Unions. Editorial explanation of the working of the great trade unions of England, especially those engaged in the engineering struggle. 1800 w. Engng—July 30, 1897. No. 14506 A.

Workers.

Workers at Gainful Occupations at the Federal Censuses of 1870, 1880, and 1890. William C. Hunt. Discussion of the classifications given in the census reports, showing a perceptible increase in the proportion of persons engaged in the higher grades of work. 11700 w. Bul of Dept of Labor—July, 1897. No. 14479 D.

MISCELLANY.

Madagascar.

The Economic Condition of Madagascar. A statement of prevailing conditions, public works, trade, productions, &c. 2500 w. Bd of Trd Jour—Aug., 1897. No. 14876 A.

Newfoundland Resources.

To Europe by Steamer in Three Days. Comment on an article by Dr. Wilfrid Grenfell, in the Toronto *Globe*, pointing out matters of interest concerning the mineral and other advantages of the province, and the facilities for traffic with not much more than a three days journey by water. 1000 w. Bradstreet's—Aug. 28, 1897. No. 14908.

Russia.

The Iron Industry of Southern Russia. (Die Eisenindustrie in Südrussland.) Giving commercial data as to production revenue and other statistics. 4000 w. Stahl und Eisen—July 1, 1897. No. 14748 D.

Social Conditions.

Are the Rich Growing Richer and the Poor Poorer? Carroll D. Wright. An interesting paper showing the falseness of the assertion and its misleading influence. 6000 w. Atlantic M—Sept., 1897. No. 14680 D.

Wheat and Silver.

Wheat Up, Silver Down—Facts. Wharton Barker, in *The American*. A consideration of the conditions of the past and present, from the view of a bimetallist. 2500 w. Min Ind & Rev—Aug. 19, 1897. No. 14858.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bronze.

The Analysis of Bronzes by Electrolysis. (Analyse des Bronzes par l'Electrolyse.) The method of Holland, in which the various constituents are separated by electric deposition with ease and accuracy. 2000 w. La Revue Technique—July 25, 1897. No. 14701 D.

Colloids.

The Electrical Transfer of Colloids. (Ueber Elektrische Wanderung von Colloiden.) A discussion of the influence of electrical currents upon phenomena of diffusion by Dr. Coehn. 2000 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14771 B.

Electro-Chemistry.

The First Principles of Electro-Chemistry. W. W. Haldane Gee. The first of a series of articles relating to the fundamental principles. 1200 w. Elec, Lond—Aug. 20, 1897. Serial. 1st part. No. 14911 A.

Electrolysis.

The Automatic Electrolytic Recording of Electric Currents. (Die Selbstaufzeichnung Elektrischer Ströme auf Elektrolytischem Wege.) Discussing the various methods of recording the strength, frequency, interruptions, &c., of electric currents by the electrolytic action upon suitably prepared paper ribbons. 9000 w. Elektrochemische Zeitschr—August, 1897. No. 14776 B.

Europe.

Electro-Chemical and Electro-Metallurgical Industries of Europe. John B. C. Kershaw. The first of a series of articles dealing with the development of these industries. A rapid survey will be given, with detailed account of those processes which have attained greater development abroad than in the United States, &c. 1800 w. Elec—Aug. 11, 1897. Serial. 1st part. No. 14615.

Laboratory.

The Electrochemical Laboratory at the Royal Technical High School at Munich. (Elektrochemischen Laboratoriums der Kgl. Bayr. Technischen Hochschule München.) A full description of this fine laboratory with numerous illustrations. 3000 w. 3 plates. Zeitschr f Elektrochemie—July 20, 1897. No. 14774 B.

Organic Chemistry.

The Relations of Electrochemistry to Organic Chemistry. (Ueber die Beziehungen der Elektrochemie zur Organischen Chemie.) Showing the numerous applications of electrochemistry to organic analysis and synthesis. 4500 w. Zeitschr f Elektrochemie—Aug. 5, 1897. No. 14775 B.

Synthesis.

The Synthesis of Organic Acids. (Ueber Synthese von Organischen Säuren.) A paper by Dr. von Miller, discussing the production of organic acids synthetically by use of the electric current. 2000 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14769 B.

Transformation.

An Electrochemical Method of Transforming Alternating into Continuous Currents. (Ueber eine Electro-Chemisches Verfahren um Wechselströme in Gleichströme zu Verwandeln.) The transformation is effected by utilization of the polarizing properties of aluminum. 2500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14772 B.

LIGHTING.

Arcs.

A Curious Alternate-Current Arc Phenomenon. Alfred Hay. Remarkable phenomenon observed in the course of some experiments on

alternate-current arcs between metallic electrodes. 800 w. Elect'n—Aug. 13, 1897. No. 14840 A.

The Phenomena of the Electric Arc. (Sur le Phénomène de l'Arc Électrique.) An account of experimental investigations of M. Blondel to determine the magnitude and nature of the resistance of the electric arc. 2000 w. Comptes Rendus—July 19, 1897. No. 14708 B.

Buffalo, N. Y.

Electric Lighting Progress in Buffalo, N. Y. Report of extensions being made which will make this city one of the best lighted in the United States. 1000 w. Elec Rev—Aug. 18, 1897. No. 14665.

Combination.

See same title under Power.

Compound Engines.

See same title under Mechanical Engineering, Engines and Motors.

Condensers.

The Employment of Condensers in Alternate Current Arc Lamps. George Claude. A new use for condensers is described, to improve the regulation of alternating current arc lamps. Past failures are explained. From *L'Industrie Electrique*. 1500 w. Elect'n—Aug. 6, 1897. No. 14633 A.

Electric Fountain.

The Electric Fountain at the Prospect Park Plaza, Brooklyn, N. Y. Illustrated detailed description of the fountain and its operation. 1800 w. Elec Eng—Aug. 19, 1897. No. 14668.

Fittings.

The Design of Electric Light and Gas Fittings. Criticism of an article published in *Lightning*, on the adaptation of electric lamps to decoration as well as illumination of domestic interiors. 1800 w. Jour Gas Lgt—July 27, 1897. No. 14491 A.

Fleet Illumination.

How the Fleet at Spithead Was Illuminated. Describes the methods adopted in securing the desired end, with a copy of the admiralty instructions. 900 w. Eng, Lond—July 30, 1897. No. 14515 A.

Garbage.

Garbage as a Fuel for Electric Light Stations. A discussion of this subject suggested by the recent installation at Shoreditch, London, setting forth some of the reasons why the success of the plan is very problematical in England and still more doubtful in America. 2000 w. Eng News—Aug. 26, 1897. No. 14895.

Gas Engines.

Failures of Gas Engines at Electric Lighting Stations. Gives records of failures, considering them more instructive than records of success. Three of the failures were recently recorded in the London *Electrician*, namely at Belfast, Morecambe, and at Coatbridge. 1200 w. Eng News—Aug. 26, 1897. No. 14893.

Isolated Plant.

An Interesting Isolated Plant at Yokohoma, Japan. Lamar Lyndon. Illustrated description of a private plant for lighting a tea factory. 2400 w. Elec Eng—Aug. 26, 1897. No. 14860.

Isolated Electric Plants versus Central Stations. Percival Robert Moses. Showing that the private plant is more economical in large installations where the load is continuous. 3700 w. Eng Mag—Sept., 1897. Serial. 2d part. No. 14900 B.

Public Lighting.

Theory of Public Lighting. Andre Blondel. From *La Genie Civil*. Discusses the use of electric lamps, the position in which they should be placed to obtain the best effect, &c. 1800 w. Ind & East Eng—July 3, 1897. Serial. 1st part. No. 14492 D.

Rectifiers.

Rectifiers for Arc Lighting. Describes an apparatus put into commercial use in England, for supplying direct current to high-tension series arc circuits from a regular alternating-current dynamo. Ill. 900 w. Elec Wld—Aug. 21, 1897. No. 14845.

Small Districts.

The Lighting of Small Districts. F. J. Warden-Stevens. Discusses the conditions affecting the lighting of small districts in England, and recommends electric lighting. 2000 w. Arch, Lond—July 30, 1897. No. 14550 A.

Theatre Lighting.

The Grand Theatre, Fulham. Illustrated description of the electric lighting arrangements. 1800 w. Elec Eng, Lond—Aug. 20, 1897. No. 14948 A.

Voltmeters.

The Voltmeter in Series Arc Stations. Alex Dow. Discusses the various uses to which a voltmeter can profitably be put in a series arc lighting station. 4400 w. Elec Engng—Aug. 1, 1897. No. 14543.

Wiring.

Electric Wiring. F. J. Warden-Stevens. Reviews the progress made in methods of wiring, considering various systems in detail, and comparing them with the conditions of a perfect system. 2500 w. Arch, Lond—Aug. 13, 1897. No. 14841 A.

Interior Wiring. Editorial discussion of the wiring rules of the Institution of Electrical Engineers. 3000 w. Elec Rev, Lond—Aug. 20, 1897. No. 14942 A.

Wiring Rules. General rules for wiring, issued by the Institution of Electrical Engineers, confined to a statement of requirements. 4800 w. Elec Eng, Lond—Aug. 13, 1897. No. 14822.

POWER.

Accident.

The Accident at the Paterson Station. Illustrated description of a singular accident in the Edison generating station at Paterson, N. J. 400 w. Elec Wld—Aug. 21, 1897. No. 14846.

Accumulators.

Quick-Charge Accumulators. M. Blanchon. Read before the Société Internationale des Electriciens. Describes the construction of the Tudor accumulator, showing what constitutes a "quick-charge" accumulator, considers the services it can render for electric traction, &c. 6000 w. Elect'n—Aug. 20, 1897. No. 14941 A.

The Computation of the Capacity of a Lead Accumulator under Variable Current. (Ueber die Berechnung der Kapazität eines Bleiakkumulators be Variabeler Stromstärke.) A mathematical discussion by Herr Liebenow. 3500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14770 B.

Traction Accumulators—Law of Maximum Work. Law of Maximum Useful Work. Desmond G. Fitz-Gerald. The opinions of the writer, with reasons. 1200 w. Elec Eng, Lond—Aug. 20, 1897. No. 14946 A.

Armatures.

On Toothed Armatures. Michael v. Dolivo-Dobrowolsky. From the *Elektrotechnische Zeitschrift.* Considers a few matters needing explanation, in the belief that putting them straight will be of value and importance. 1800 w. Elec Eng, Lond—Aug. 6, 1897. No. 14596 A.

See same title under Mechanical Engineering, Shop and Foundry.

Some Remarks on Slot and Tunnel Armatures. M. von Dolivo-Dobrowolsky. From the *Elektrotechnische Zeitschrift.* Explanation of peculiarities and facts not generally understood. Ill. 1500 w. Elect'n—Aug. 20, 1897. No. 14938 A.

Automobiles.

See same title under Mechanical Engineering, Miscellany.

Battery.

A Gas Carbon Element. (Ueber ein Kohlen-Gas Element.) A new carbon element consisting of carbon and copper electrodes in a solution of salammoniac or a metallic salt, traversed by a stream of carbonic oxide. 7500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14768 B.

Combination.

Combined Lighting and Traction. Andrew Stewart. Notes on combined lighting and traction systems showing them to be both profitable and economical. 1800 w. Elec, Lond—July 30, 1897. No. 14501 A.

Cranes.

Cranes with Electric Motive Power. (Ueber einige Hebe-Apparate mit Elektrischem Antrieb.) Describing and illustrating the electric traveling and locomotive cranes and hoists built by the Oerlikon Works. 5000 w. Schweizerische Bauzeitung—Aug. 7, 1897. No. 14766 B.

Dynamos.

Dynamo Design. Albert W. Smith. Proposes a design that overcomes some of the objectionable features of the usual type. 1500 w. Elec Eng—Aug. 12, 1897. No. 14561.

Electric Mining.

See same title under Mining and Metallurgy, Mining.

Electric Plants.

The Construction of Electric Plants in View of Future Tramway Service. (Wie Soll Man Elektricitäts Werke Bauen um von Ihnen auch die Strassenbahnen treiben zu Können?) A discussion of a problem of frequent occurrence in Germany and elsewhere, with suggestive details. 2000 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14781 B.

Elevators.

Electric Elevator Problems and Some of Their Solutions. J. E. Woodbridge. Discusses the reasons for the increased economy of power of the electric elevator over the hydraulic, the difficulties encountered in elevator service, the Leonard system and its disadvantages, &c. 3500 w. Elec Wld—Aug. 7, 1897. No. 14537.

Motors and Details for Electric Elevators. (Motoren und Hülfsapparate für elektrisch betriebene Hebezeuge.) Discussing the best forms of motors, regulators, controlling apparatus, &c., with numerous diagrams. Serial, 2 articles. 12000 w. Zeitschr d Ver deutscher Ing—July 3, Aug. 7, 1897. No. 14721 E.

Passenger Elevators. (Ueber Personenaufzüge.) A discussion of the best arrangement of passenger elevators, as to location in building as well as motive power, with plate of details of hydraulic and electric elevators. 7000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—July 23, 1897. No. 14725 B.

Failures.

Causes of Failure in Electrical Plant. Sydney F. Walker. Considers the causes by means of which an electrical apparatus either refuses to do its proper work at all or does it imperfectly. 3200 w. Col Guard—Aug. 20, 1897. No. 14927 A.

Haulage.

See same title under Marine Engineering.

Instantaneous Voltage.

Diagrams of Instantaneous Voltage in Alternate Current Circuits. H. N. Allen. Describes method of obtaining a clear idea of the variation of potential throughout the circuit. The instantaneous voltages, for any moment during the period, are plotted as ordinates and the impedances of the circuit as abscissae. 1600 w. Elect'n—Aug. 20, 1897. No. 14940 A.

Machine Driving.

Electric Motors at the Ramapo Iron Works. An account of the introduction of small electric motors for driving machinery. 1000 w. R R Gaz—Aug. 20, 1897. No. 14803.

Niagara Power.

Lord Kelvin and the Niagara Power Transmission. Orrin E. Dunlop. An account of an interview on the occasion of Lord Kelvin's recent visit. Ill. 1600 w. Elec Eng—Aug. 26, 1897. No. 14861.

Plows.

Electrically Driven Plows. (Elektrisch Betriebene Pflüge.) Describing especially the Zimmermann system, with gang plow hauled by a chain operated by electric motor mounted on the

plow. Two articles. 7000 w. Die Elektrizität —July 17 & 31, 1897. No. 14785 D.

Potentiometer.

A Wide Range Potentiometer. L. H. Fry. Describes a potentiometer designed by Herr Thiermann of the Hanover Polytechnikum, devised especially for the calibration of voltmeters, but which is also adapted for all current and resistance measurements. 1200 w. Elec Rev, Lond—Aug. 20, 1897. No. 14943 A.

Station.

A German Three-Phase Central Station. Illustrated detailed description of the plant at Strassburg, Germany. 5400 w. Am Elect'n—Sept., 1897. No. 14953.

Windsor Electricity Works. Illustrated detailed description of works and equipment. 3300 w. Elec Eng, Lond—July 30, 1897. No. 14510 A.

St. Lawrence River.

Electric Power from the St. Lawrence River. Details concerning an important project near Massena, N. Y. Ill. 3000 w. Elec Rev—Aug. 4, 1897. No. 14464.

The Massena Water-Power Electrical Generating Plant. Brief illustrated description of some of the important features. 500 w. Am Elect'n—Sept., 1897. No. 14954.

Transformers.

The Predetermination of the Regulation of a Transformer with Non-Inductive Load. F. Bedell, R. E. Chandler, and R. H. Sherwood, Jr. Presented at the Detroit meeting of the Am. Assn. for the Advancement of Science. Gives a method for determining the exact regulation of a transformer without the necessity of applying a load. 2300 w. Elec Wld—Aug. 14, 1897. No. 14630.

Water Power.

Hydro-Electric Power Stations in the United States. Part first gives information of the plant at St. Anthony's Falls. 1000 w. Elec Rev, Lond—Aug. 6, 1897. Serial. 1st part. No. 14625 A.

TELEGRAPHY AND TELEPHONY.

Cables.

The Limits of Speed in Working Submarine Cables as Affected by Faults or Leaks, and by the Proportions of the Materials. W. A. Price. Determines, by calculation, the effect of such faults on the signalling. 2200 w. Elec Rev, Lond—Aug. 6, 1897. No. 14627 A.

Exchange.

The Strowger Automatic Telephone Exchange, at Amsterdam, N. Y. Illustrated description of a plant of the latest type. 1700 w. Elec Eng—Aug. 12, 1897. No. 14560.

The Strowger Automatic Telephone Exchange, Augusta, Ga. Illustrated description of what is said to be the largest automatic telephone exchange in the world. 1500 w. Elec Eng—Aug. 5, 1897. No. 14466.

Gilgit Telegraph Line.

An Incident in the Working of the Gilgit Telegraph Line. Extract from the *Electrician*. An interesting account of adventure and heroism on the part of Indian telegraph department officials and native staff. 1600 w. Ind & East Eng—July 24, 1897. No. 14881 D.

High-Speed Telegraphy.

High-Speed Telegraphy in Connection with an Alaska-Russian Telegraph Line. Reginald A. Fessenden. Discusses the value of a telegraph line through Alaska, stating the circumstances which in the writer's opinion favor the construction. 1300 w. Elec Wld—Aug. 7, 1897. No. 14534.

MISCELLANY.

Alternating Currents.

New Optical Method of Studying Alternating Currents. (Nouvelle Methode Optique d'Etude des Courants Alternatifs.) Describing an improvement in the strobosopic method of M. Pionchon, devised by MM. Abraham and Buisson. 120 w. Comptes Rendus—July 12, 1897. No. 14705 B.

Aluminum.

Aluminum as a Material for Electrical Conductors. (Ueber Aluminum als Leitungs Material.) A discussion of the relations between weight, conductivity and cost, which may render aluminum conductors practicable. 1200 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14779 B.

Circuit Breakers.

I. The Fuse and the Circuit Breaker. W. M. Stine. II. Circuit Breakers vs. Fuses. T. W. Bevan. Two articles in defense of circuit breakers. 2000 w. Am Elect'n—Sept., 1897. No. 14955.

Coil Experiments.

Interesting Information on Tesla Coil Experiments. Elliott Woods. The results of the writer's experience are given. 900 w. Elec Rev—Aug. 18, 1897. No. 14667.

Conduit Construction.

Conduit Construction in St. Louis. Frank Clark Cosby. An account of the work of placing wires under ground. The various wire-using companies have selected various styles of conduits, thus giving an opportunity of comparing work under the same conditions, but involving nearly all types of conduit in the market. Ill. 1800 w. Elec Wld—Aug. 21, 1897. Serial. 1st part. No. 14847.

Dangers.

Dangers Connected with the Supply of Electricity. From the report of the committee appointed by the Home Office. 1700 w. Arch, Lond—Aug. 6, 1897. No. 14645 A.

Diamagnetic Substances.

Researches in Diamagnetic and Feebly-Magnetic Substances. Luigi Lombardi. Investigations at the Federal Polytechnic of Zurich. The research is chiefly confined to solid diamagnetic bodies, and the results show clearly the absence of hysteresis. 2400 w. Elect'n—Aug. 6, 1897. No. 14634 A.

Electrical Code.

The National Electrical Code. Part first begins an outline of the evolution of electrical rules from the beginnings to the present time. 2400 w. Elec Rev—Aug. 18, 1897. Serial. 1st part. No. 14666.

Electrical Cooking.

The Economy and Utility of Electrical Cooking Apparatus. John Price Jackson. Describes tests made with the hope of obtaining a method of cooking that would be satisfactory with a minimum risk of fire. Results showing the cost of cooking by coal to be about 19% of the cost by electricity. 1500 w. Elec Wld—July 31, 1897. No. 14451.

Electric Furnace.

The Electric Furnace. F. Jarvis Patten. Part first is mostly historical with illustrations of the earliest patents. 1200 w. Elec Eng—Aug. 12, 1897. Serial. 1st part. No. 14559.

Electrical Regulations.

See same title under Economics and Trade, Labor.

Electricity.

Electricitv During the Last Five Years. Franz Bendt. Translated from the German *Ueber Land und Meer*. Reviews briefly the history of the science and the most recent advances. 2200 w. Chau—Sept., 1897. No. 14961 C.

Electricity and Magnetism.

A Course of Reading on Electricity and Magnetism. F. A. C. Perrine. Points out a course of reading for a student who wishes to lay a firm foundation for a working knowledge of engineering. 2000 w. Elec Engng—Aug. 15, 1897. No. 14883.

Electric Heat.

The Use of Electric Heat in the Manufacture of Hats. Illustrated description of the electrically treated ironing appliances as adopted in the factory of Budish & Yudizky, of Newark, N. J. 1400 w. Elec Wld—July 31, 1897. No. 14450.

Galvanometer.

The Ballistic Galvanometer in Theory and Practice. Ellis H. Crapper. The first of a series of articles on experimental work with this instrument. Defines and explains the theory. Ill. 1500 w. Elec Eng, Lond—Aug. 20, 1897. Serial. 1st part. No. 14947 A.

India-Rubber.

Substitutes for India-Rubber. H. L. Terry. Discusses this subject, pointing out the danger with which users of India-rubber for electrical purposes are threatened. 2000 w. Elect'n—Aug. 6, 1897. No. 14632 A.

Induction.

Induction in Short Soft Iron Magnets. H. O. Eurich. A short summary of results obtained in a series of experiments at the Electrical laboratory of the Yorkshire College, Leeds. 600 w. Elec Rev, Lond—Aug. 6, 1897. No. 14626 A.

Lightning.

Improvements in Lightning Conductors. (Vereinfachung der Gebäudeblitzableiter.) A very full discussion before the Electrotechnical Society. 20000 w. Electrotech Zeitschr—Aug. 5, 1897. No. 14789 B.

Meters.

Perfected Clockwork Electric Meter. (Vervoll Kommneter Uhrenzähler.) Aron's Improved electric meter, operates by the electric control of a clockwork escapement system. 4500 w. Electrotech Zeitschr—July 1, 1897. No. 14786 B.

The Meters of To-day. R. F. Schuchardt. Read at meeting of the Northwestern Electrical Assn. Investigations show that meters are not all that might be desired. Points to be considered in selecting a meter are given. 1600 w. Elec Wld—July 31, 1897. No. 14452.

Titration.

A Galvanometric Method of Titration. (Ueber eine Galvanometrische Titrier Methode.) A paper by Dr. Salomon showing the applicability of the method of measuring electric currents to the solution of problems in volumetric analysis. 2000 w. Zeitsch f Elektrochemie—July 20, 1897. No. 14773 B.

X-Rays.

Endoscopy. G. Brunel, in *La Revue des Revues*. An account of numerous and beneficial applications of the X-rays. 1800 w. Sci Am Sup—Aug. 14, 1897. No. 14569.

Tesla on the Source of Roentgen Rays and the Practical Construction and Safe Operation of Lenard Tubes. Nikola Tesla. Illustrated account of the writer's investigations and report of results. 3500 w. Elec Rev—Aug. 11, 1897. No. 14556.

The Action of X-Rays, &c. (De l'Action des Rayons X, &c.) Three Papers before the French Academy discussing experimental researches, chiefly relating to the use of X-rays for investigating flaws in metals. 2500 w. Comptes Rendus—July 19, 1897. No. 14709 B.

The Transformation of X-Rays by Metals. (Sur la Transformation des Rayons X par les Métaux.) A note presented to the French Academy by M. Sagnac, showing feeble reflections and other phenomena effected by certain metals. 1200 w. Comptes Rendus—July 26, 1897. No. 14713 B.

The X-Rays in the Custom House. Brief explanation of the method, with illustrations. 1800 w. Sci Am—Aug. 7, 1897. No. 14470.

Underground Mains.

The Localization of Faults in Underground Mains. Robert C. Quinn. Read before the Municipal Electrical Assn., at Manchester, Eng. Results from the large experience of the writer, methods used and the reasons why he adopted the final method. Discussion and illustrations, with editorial. 6500 w. Elect'n—July 30, 1897. No. 14524 A.

MARINE ENGINEERING.

Armor.

Hardened Plates and Broken Projectiles. L. E. Bertin. Read at the International Congress of Naval Architects and Marine Engineers. On Harveyed plates, their trials, &c. Part first presents a summary analysis of Mr. Ellis' tables, contained in a study of the American Navy. A study of the penetration. 3000 w. Engng—July 30, 1897. Serial. 1st part. No. 14508 A.

Battle-Ship.

Contract Trial of the United States Sea-Going Battle-ship, Iowa. J. M. Pickrell. Illustrated detailed description of the vessel and its equipment with report of speed trial. 8400 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14481 H.

Docks.

Manchester Ship Canal Dock Warehouses. Illustrates and describes two of the blocks of warehouses erected by the Ship Canal Warehouseing Co., Limited. General plan is given. 1400 w. Eng, Lond—July 30, 1897. No. 14516 A.

Repairs to Dry Dock No. 3 at the Brooklyn Navy Yard. Brief general description of the work. 600 w. Sci Am—Aug. 28, 1897. No. 14862.

Electrical Equipment.

Electricity on the Steamship "Bremen." Illustrated description of a vessel of the North German Lloyd line, which is said to be more fully equipped electrically, than any other vessel of the merchant marine. 900 w. Ir Age—Aug. 5, 1897. No. 14437.

Engineering.

The Future of Engineering in the Navy. Reviews some of the changes that would improve the smooth running of the engineering department of a ship. 2800 w. Ir Age—Aug. 5, 1897. No. 14440.

Gunboats.

Contract Trial of the U. S. S. Nashville. W. Strother Smith and C. B. Price. Illustrated description of vessel, furnishings and equipment, with data of trial. 4300 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14486 H.

The Contract Trial of the U. S. Gunboat Annapolis. C. H. Mathews. Illustrated detailed description with data of trial. 2500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14484 H.

The Contract Trials of the U. S. Gunboats Vicksburg and Newport. H. N. Stevenson. Description, with principal dimensions of engine and account of trials. Ill. 2500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14483 H.

Haulage.

The Electric Traction of Boats. (La Traction Electrique des Bateaux.) An illustrated account of the Denèfle system of electric trolley haulage for canal boats now being tested on several French canals. 1 plate. 2500 w. La Revue Technique—July 25, 1897. No. 14700 D.

Inland Navigation.

Inland Navigation in the United States. Extracts from a paper by Smith S. Leach, presented to the Inst. of Civ. Engs. A brief summary of the extent of inland navigation in this country. 500 w. Eng News—Aug. 19, 1897. No. 14697.

Lighthouses.

Lighthouse Illumination in Japan. C. S. Du Riche Preller. Illustrated description of the salient features of the new Japanese light, erected in the Island of Formosa. Lightning flash apparatus. 1400 w. Engng—July 30, 1897. No. 14503 A.

Marine Engineering.

Fifty Years of Advance in Marine Engineering. Ridgely Hunt. Showing the increase, since 1840, in horse-power, steam pressure, tonnage, speed, etc. Ill. 4500 w. Eng Mag—Sept., 1897. No. 14901 B.

Marine Engines.

Modern Improvements in Marine Engine Practice. Editorial on paper by Messrs. A. J. Durston, and J. T. Milton, reviewing recent improvements and commenting on future prospects. 2200 w. Eng News—Aug. 5, 1897. No. 14487.

Rotary vs. Reciprocating Marine Engines. Charles Algernon Parsons. Presents the relative advantages and disadvantages of rotary and reciprocating engines as applied to ship propulsion. Read at the Inst. of Civ. Engs—Engineering Conference. Ill. 1500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14485 H.

The Jubilee of Messrs. A. and J. Inglis. A review of the work of this firm, with illustrations of the paddle engines of the old tugboat Clyde, built 47 years ago and still doing duty. 2300 w. Engng—July 30, 1897. No. 14505 A.

Mercantile Marine.

The French Mercantile Marine. Editorial review of the conditions in France causing the decadence of the mercantile marine. 1800 w. Eng, Lond—Aug. 13, 1897. No. 14834 A.

Monitors.

Reconstructed American Monitors. F. M. Bennett. The history of the Puritan is given as an example of the class, experience in a reconstructed monitor related, and the means by which the worst faults were corrected, with much other information. 9500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14482 H.

Newfoundland Resources.

See same title under Economics and Industry, Miscellany.

Princess Anne.

Latest Addition to the Fleet of the Old Dominion Steamship Co. Illustrated description of a fine coast line vessel. 2000 w. Marine Engng—Aug., 1897. No. 14557 C.

Propeller.

The Sheathed Propeller. Describes a small propeller of peculiar construction, lately put on the market by the Sheathing Propeller Company of London. Ill. 800 w. Sci Am Sup—Aug. 7, 1897. No. 14473.

Pumping.

Recent Improvements in Pumping Machinery for Marine Service. John A. Drew. Read at meeting of Consolidated Association of Marine Engineers. History of the direct-acting steam pump. Ill. 3000 w. Steamship—Aug., 1897. No. 14496 A.

Safety.

Life Saving Appliances. (Les Moyens de Sauvetage.) Giving the text of the new French law providing for life saving appliances at sea, with discussion, by M. Dibos. 3500 w. La Revue Technique—July 25, 1897. No. 14703 D.

Signalling Gear.

Multiphase Signalling Gear. C. Arldt. Abstract of a paper read at the Eisenach meeting of the Verband Deutscher Elektrotechniker. Illustrated description of instruments used at water works, on board vessels, &c. 1000 w. Elec Eng, Lond—Aug. 20, 1897. No. 14949 A.

Spithead.

Naval Review at Spithead in Honor of Queen Victoria's Jubilee. John D. Ford. Interesting account of the naval vessels and incidents of the review, by the chief engineer of the U. S. S. Brooklyn. 3300 w. Marine Engng—Aug., 1897. No. 14558 C.

Steamboat.

The Danube River Side-Wheel Steamboat "Francis Joseph I." Illustrated description of an interesting example of foreign practice. 900 w. Eng News—Aug. 26, 1897. No. 14894.

The Danube Steamer "Francis Joseph I." (Der Donaudampfer "I. Ferencz Jozsef.") Full details of this fine new river steamer, with drawings of boilers, engines and hull. 2 plates. 3000 w. Zeitschr d ver deutscher Ing—July24, 1897. No. 14715 B.

Submarine Vessels.

Submarine Vessels. A description of the "Plunger" recently launched at Baltimore, as given in the *Baltimore Sun*. 2300 w. Eng——Aug. 21, 1897. No. 14866.

Water-Tube Boilers.

Water-Tube Boilers in High-Speed Ocean Steamers. P. Sigaudy. Paper submitted at the International Congress of Naval Architects and Marine Engineers. Claiming that the next important step in ocean steam navigation will be the adoption of the water-tube boiler. 1500 w. Steamship—Aug., 1897. No. 14497 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers.

Installation of Boilers. (Aufstelling von Dampfkesseln.) The official rules of the Prussian Government covering the details of steam boiler installation, as revised June 30, 1897. 2500 w. Zeitschr d ver deutscher Ing—Aug. 7, 1897. No. 14724 B.

The Dubian Improvements in Steam Boiler Construction. (Die Neuen Dampfkessel mit Dubian's cher Emulsions-Einrichtung.) Describing the Dubian emulsion tubes as connected to boilers of various designs, for the improvement in the circulation and the prevention of foaming. 6000 w. Zeitschr d Oesterr Ing u Arch ver—July 30, 1897. No. 14727 B.

The Proportions of Locomotive Boilers. Editorial criticism of the investigations on the proper ratio of heating surface and grate area to cylinder volume for passenger and freight engines, made by the committee of the American Ry. Mas. Mech. Ass'n. 1600 w. Eng, Lond—Aug. 20, 1897. No. 14934 A.

Uniform American Boiler Specifications. E. D. Meier. Read at recent convention of American Boiler Manufacturers' Assn. A comparison of present regulations here and abroad, with general consideration of the subject. 4000 w. Ir Age—Aug. 26, 1897. No. 14873.

Feed Water.

Normand's Feed Regulating Arrangement. Illustrated description of an arrangement patented by Augustin Normand & Co., of Havre, which has already been successfully tried. 600 w. Engng—Aug. 20, 1897. No. 14918 A.

Gages.

Concerning Mercury Columns. From *The Locomotive*. Method used in standardizing gages is explained. 2000 w. Mas St Fit—July, 1897. Serial. 1st part. 14431.

Corrosion and Breakage of Water Gage Glasses. G. D. Hiscox. Gives theories explaining the different cracking and breaking of glasses. 1300 w. Sci Am Sup—Aug. 7, 1897. No 14474.

Water-Tube Boilers.

See same title under Marine Engineering.

COMPRESSED AIR.

Compressor.

Corliss Air Compressor. (Corliss Luft Kompressor.) A powerful air compressor, with compound steam cylinder, and Corliss valves on the air cylinder, mechanically operated. The spring discharge valves are contained in the Corliss admission valves. 4500 w. 1 plate. Gluckauf—July 17, 1897. No. 14740 B.

Explosion.

Explosion of an Air Compressor at Dortmund. (Explosion eines Luft Kompressors bei Dortmund.) This fatal explosion was due to the gasification of the lubricant and ignition of the mixed gas and air by overheated portions of the machine. A curious and important case. 2500 w. Gluckauf—June 26, 1897. No. 14738 B.

Liquid Air.

Liquid Air and its Uses. G. D. Hiscox. An

interesting account of its action on various substances, its appearance, advantages, &c. 2500 w. Compressed Air—Aug., 1897. No. 14672.

Motors.

Compressed Air Motors. Illustrated detailed description of the Hoadley-Knight motors, their construction and working. 3500 w. St Ry Jour—Aug., 1897. No. 14402 D.

ENGINES AND MOTORS.

Blowing Engine.

Horizontal Blowing Engine for Blast Furnace (Liègende Gebläsemaschine für Hochöfen.) Elevation, plan, and description of 700 H. P. double compound blowing engine. 1000 w. Zeitschr d Ver deutscher Ing—July 31, 1897. No. 14719 B.

Compound Engines.

Compound Engines and the Cost Account. R. H. Thurston. Discussion of what type of engine shall be used. 2300 w. Bos Jour of Com—Aug. 14, 1897. No. 14619.

Counterbalance Tests.

Counterbalance Tests of the Strong Engine at Purdue University. Report of recent tests, with conclusions, and editorial comment. 1500 w. R R Gaz—Aug. 6, 1897. No. 14477.

Cut-off.

Most Economical Cut-off. From advance sheets of Buckeye Engine Company's catalogue. Gives results of experiments of Professor Denton. 700 w. Am Mach—Aug. 5, 1897. No. 14468.

Engine Trials.

Superheated Steam Engine Trials. William Ripper. Read before the Inst. of Civil Engs. Describes experiments made to determine the steam consumption, dryness, nature of the heat exchange, and conclusions that may assist in the future development of superheating. Ill. 3000 w. Prac Eng—July 30, 1897. Serial. 1st part. No 14523 A.

Gas Engines.

Gas Engines. W. F. Kelly. Abridged from a paper read before the Engineers' Club of Columbus, O. Brief consideration of the different types and the more important features, with remarks on cost, economy, durability, &c. 2500 w. San Plumb—Aug. 15, 1897. No. 14660.

Gas Engines in French Flour Mills. Describes in detail an engine which received a Grand Prix at the International Exhibition at Rouen, in 1896, and has recently been erected to supply 530-horse power in a flour mill in Paris. Ill. 1200 w. Engng—Aug. 13, 1897. No. 14824 A.

Large Gas Engines. Gives advantages as compared with steam engines, showing that in England they are worked with economy. 1200 w. Bos Jour of Com—Aug. 7, 1897. No. 14499.

See Same title under Electrical Engineering, Lighting.

The Fairbanks-Morse Gas and Gasoline Engines. Presents some of the essential features of the engine made by this company. Ill. 1200 w. R R Gaz—Aug. 20, 1897. No. 14805.

The Sintz Gas and Gasoline Engines. The Sintz gasoline oil engine is illustrated and described. It is an American engine, operating with a two-stroke cycle. 1000 w. Eng News—Aug. 12, 1897. No. 14593.

Heat Motor.

Diesel's Rational Heat Motor. (Diesels Rationeller Wärmemotor.) A report of a test by Prof. Schröter, of Munich, of the new Diesel motor, showing the remarkable efficiency of 38.5 per cent. A valuable article on testing a motor. 8000 w. Zeitschr d Ver deutscher Ing—July 24, 1897. No. 14714 B.

High-Speed Engines.

High-Speed Self-Lubricating Steam Engines. Alfred Morcom. An important paper on quickly rotating engines and automatic lubrication read at meeting of the Inst. of Mech. Engs. at Birmingham, Eng. 5000 w. Eng, Lond—Aug. 6, 1897. No. 14606 A.

Leakage.

Leakage Tests of Valves and Pistons. From advance proofs of a book on "Engine Tests," by George H. Barrus. The importance of such tests and the methods of making them are discussed. 1600 w. Eng Rec—Aug. 21, 1897. No. 14830.

Link Motion.

The Locomotive Link Motion. F. A. Halsey. Part first discusses the applicability of the link motion to locomotive conditions and compares the stationary and shifting link motions, &c. 2200 w. Am Mach—Aug. 26, 1897. Serial. 1st part. No. 14886.

Marine Engines.

See same title under Marine Engineering.

Oil Engines.

Calculations for Oil Engines. W. H. Booth. Showing how the amount of cooling water may be found. 1400 w. Am Mach—Aug. 5, 1897. No. 14469.

Oil Engines. J. Warren. Presents some of the details of construction and working in connection with the leading oil engines at present in the market. 1500 w. Elec, Lond—July 30, 1897. No. 14502 A.

Pistons.

Piston Packing Rings of Modern Steam Engines. Otto C. Reymann. Investigates the methods of securing a steam-tight piston, and how packing rings are to be designed in order to exert the required pressure on the cylinder walls, devises formulæ for ring types generally used. 3500 w. Jour Fr Inst—Aug., 1897. Serial. 1st part. No. 14446 D.

Power Production.

The Economical Production of Power in Small Units. E. T. Adams. Showing the desirability of developing small engines with higher fuel-economy. 3200 w. Eng Mag—Sept., 1897. No. 14903 B.

Pumping.

Duplex Pumps. Their action, and why positively closed water valves permit of high speeds. 1500 w. Bos Jour of Com—Aug. 7, 1897. Serial. 1st part. No. 14498.

See same title under Marine Engineering.

Test of a High Speed Pumping Engine with a New System of Water Valves. Report of two tests recently made by H. W. Spangler and Edward T. Child. Shows that the capacity and speed of a pump may be increased 50% by simply changing the water valves. 2400 w. Eng News—Aug. 5, 1897. No. 14489.

Valves.

Engine Valve Motions. Theo. F. Scheffler, Jr. Comments on the general redesigning of valve motions which seems to be taking place, and describes a few of the most modern types of engines, particularly with reference to valve motion. 2800 w. Sci Mach—Aug. 1, 1897. No. 14436.

POWER AND TRANSMISSION.

Coal Shipment.

See same title under Mining and Metallurgy, Coal and Coke.

Hydrodynamics.

Establishment of a Uniform Flow in a Tube of Circular Section. (Etablissement du Régime Uniforme dans un Tuyan à Séction Circulaire.) A further discussion by M. Boussinesq, extending his analytical investigations to tubes of circular cross-section. 3000 w. Comptes Rendus—July 26, 1897. No. 14711 B.

Establishment of a Uniform Flow in a Pipe of Large Rectangular Section. (Etablissement du Régime Uniforme dans un Tuyan à Section Rectangulaire Large.) A discussion of this important problem by M. Boussinesq, with analytical formulas. 3000 w. Comptes Rendus—July 19, 1897. No. 14706 B.

Theory of Gradually Varying Flows of Different Rates. (Théorie Approchée du Passage d'un Régime Graduellement Varie à un Régime Rapidement Varié.) An elaborate mathematical treatment by M. Boussinesq. 3000 w. Comptes Rendus—July 12, 1897. No. 14704 B.

Pulleys.

The High Side of a Pulley. Points on the running of belts and the action of pulleys. Ill. 1300 w. Am Mach—Aug. 19, 1897. No. 14691.

Steam Power.

The Cost of Steam Power. Horatio A. Foster. Abstract of paper read before the Am. Inst. of Elec. Engs. Showing that any general statement of the cost of power per horse power per annum is incorrect, and that no such statement is of any value unless for plants employed in similar work under similar conditions. Gives tabulated data of plants tested. 4000 w. St Ry Jour—Aug., 1897. No. 14460 D.

Water Power.

The Limitations of Government in Water-Power Plants. Mark A. Replogle. Discusses the factors that determine the regulation of the speed. 1000 w. Am Mach—Aug. 19, 1897. No. 14692.

Windmills.

Influence of Load on the Power of a Windmill. E. C. Murphy. Shows by diagrams how the power of a windmill varies with the load on it. Ill. 1000 w. Eng News—Aug. 19, 1897. No. 14695.

SHOP AND FOUNDRY.

Armatures.

On the Construction of Armature Cores. William Baxter, Jr. Discusses past and present methods. Ill. 2300 w. Am Mach—Aug. 12, 1897. No. 14581.

Casting.

Casting a Difficult Metal. Methods used by the writer to get a perfect casting of copper, with the addition of from eight to twelve per cent. of aluminum. Ill. 700 w. Ir Trd Rev—Aug. 26, 1897. No. 14914.

Centering.

Centering. A. H. Cleaves. Methods are described and devices illustrated. 900 w. Am Mach—Aug. 19, 1897. No. 14689.

Cycles.

Some Points in Cycle Construction. F. J. Osmond. Read before the Inst. of Mech. Engs. Considers the causes of inefficiency to be want of rigidity and friction. Discusses also the factor of safety, large tubes, aluminum frames, testing of tubes, chain stays, gear and crank length, &c. 4000 w. Eng, Lond—July 30, 1897. No. 14518 A.

Dies.

Drawing Dies. J. L. Lucas. Illustrated description of the work. 1100 w. Am Mach—Aug. 12, 1897. No. 14576.

Fluid Iron.

The Pressure of Fluid Iron. R. D. Moore, in *Iron Molders' Journal.* The importance of rule for estimating the pressure of the metal on the mold. 1000 w. Ir Trd Rev—Aug. 19, 1897. No. 14688.

Fly-Wheels.

The Arms of Fly-Wheels Cast in One Piece—A Method of Constructing Additional Diagrams. Henry Hess. Diagrammatic solutions, with explanations. 1200 w. Am Mach—Aug. 12, 1897. No. 14579.

Gearing.

The Practical Delineation of Gear Teeth. (Sur le Tracé Pratique des Engrenages.) M. Le Cornu. The curves are assumed to be circular arcs, and the variation from uniform angular velocity is deduced. 1000 w. Comptes Rendus—July 19, 1897. No. 14707 B.

Joints.

Efficiency of Oblique Riveted Joints. Abstracted from *The Locomotive.* Explains what is meant by efficiency, and discusses how to find the effective efficiency. Ill. 1300 w. Am Mach—Aug. 12, 1897. No. 14578.

Lathes.

Small Error Limits in Large Lathes. John Randol. Discusses the error limit allowable, and cites the case of two 60-inch lathes of the same dimensions and details, recently ordered, one of which was accompanied by a minute detail of error limits and cost twice as much. Questions whether this excess of cost money was well spent. 2500 w. Am Mach—Aug. 26, 1897. No. 14884.

Machinery.

Manufacturing Methods as Applied to the Production of Machinery. F. A. Halsey. Introductory portion of a lecture before the engineering students of Cornell University. The methods described relate more to manufacture by the aid of special fixtures, rather than by special machines, and refer to pure machine-shop operations only. Am Mach—Aug. 19, 1897. No. 14693.

Pattern Making.

Selecting Pine for Pattern Making. John M. Richardson. Directions for detecting undesirable qualities. 800 w. Am Mach—Aug. 19, 1897. No. 14690.

Pipe Foundry.

The Chattanooga Pipe Foundry. Illustrated description of a new plant recently erected by the Chattanooga Foundry and Pipe Company. 1000 w. Am Mach—Aug. 12, 1897. No. 14577.

Tools.

Pump Center Dividers—Some Drilling Tools. A. H. Cleaves. Illustrated description of tools and methods of work. 900 w. Am Mach—Aug. 26, 1897. No. 14885.

Workshops.

The Management of Small Engineering Workshops. R. Y. R. The first of a series of articles which will consider the management of small shops, employing up to 150 or 200 hands, confining the attention to the internal working. 1700 w. Prac Eng—Aug. 13, 1897. Serial. 1st part. No. 14849 A.

Wrench Blanks.

Trimming Wrench Blanks. W. A. Warman. Illustrated description of arrangement used and found speedier and cheaper than milling. 600 w. Am Mach—Aug. 12, 1897. No. 14580.

MISCELLANY.

Automobiles.

Electrical Cabs. Describes the cabs put into service by the London Electrical Cab Company. 1700 w. Engng—Aug. 20, 1897. No. 14923 A.

Electric Motor-Cab Service in New York City. Illustrated description of the mechanically propelled vehicles, the station, motors, and steering and brake gear are given in part first. 2800 w. Elec Wld—Aug. 14, 1897. Serial. 1st part. No. 14628.

Heavy Motor Car Trials in France. An account of the recent trials of these vehicles made under direction of the Automobile Club de France. 4000 w. Eng, Lond—Aug. 20, 1897. No. 14933 A.

The Present Status of the Horseless Carriage Industry. W. Worby Beaumont. A descriptive article, comparing the various automobiles and their achievements, and showing that, while the motor vehicle is not yet perfect, it has reached the practical stage. Ill. 5000 w. Eng Mag—Sept., 1897. No. 14905 B.

Ball Bearings.

Experiments with New Forms of Ball Bearings. F. A. Farnsworth. Drawings, with description, of several new forms of ball bearings with which the author has experimented. 900 w. Ir Age—Aug. 5, 1897. No. 14439.

Balloon Expedition.

The Andree Balloon Expedition to the North Pole. Notes on this undertaking, which has been planned by engineers. Describes the arrangements and the departure. 2300 w. Eng News—Aug. 12, 1897. No. 14594.

Bicycles.

Points in Cycle Construction. F. J. Osmond. Synopsis of a paper read at recent meeting of the Inst. of Mech. Engs. at Birmingham, Eng. Importance of rigidity, factor of safety, design, &c., are considered. 1200 w. Ir Trd Rev—Aug. 19, 1897. No. 14687.

Tension of Spokes in Bicycle Wheels. D. W. Hering. A study of this subject, examination being made of the wheels of five high-grade machines. 2000 w. Eng News—Aug. 12, 1897. No. 14592.

The Bicycle as a Vehicle and in Military Service. (Das Fahrrad als Verkehrsmittel und im Heeresdienst.) Giving an account of the extent to which the bicycle has already been adopted in various armies, with suggestions for future use. 4500 w. Stahl und Eisen—July 15, 1897. No. 14751 D.

The Cycle Market. G. Lacy Hillier. Briefly reviews the history of the development of the bicycle and the causes of over production, predicting a severe crisis in the near future. 3000 w. Contemporary Rev—Aug., 1897. No 14587 D.

Drills.

Thomas Drill with Regulating Ratchet. Jules Collin. Communication made to the Association des Ingénieurs sortis des l'Ecole de Liège. Gives particulars of this new apparatus, with illustrations. 1000 w. Col Guard—July 30, 1897. No. 14521 A.

Education.

The Electrotechnic Institute of the Stuttgart Technical High School. (Das Elektrotechnische Institut der Technischen Hochschule Stuttgart.) With floor plans, showing the arrangement of lecture halls, class rooms and laboratories. 5000 w. Zeitschr d Ver deutscher Ing—July 31, 1897. No. 14718 B.

The True Basis of Technical Education. W. Slingo. Read before the International Congress on Technical Education. The first aim should be to fit the student for a particular industry, and enable him to perform his work in a superior manner. Gives suggestions. 3500 w. Elect'n—Aug. 20, 1897. No. 14939 A.

Grindstones.

The Strains in Grindstones and Emery Wheels. (Der Spannungszustand in Schleifsteinen und Schmirgelscheiben.) A mathematical discussion of the conditions in rapidly revolving grinding wheels by Prof. Grübler of Charlottenburg, as a result of investigations into a recent disaster at Spandau. 4500 w. Zeitsch d Ver deutscher Ing—July 24, 1897. No. 14717 B.

Ladle.

Locomotive Ladle. (Locomotivgiess wagen.) A traveling ladle including crane, and propelling machinery, the whole traveling on a track. The ladle has a capacity of 25 tons. Photograph and elevation. 1000 w. Stahl und Eisen—July 15, 1897. No. 14749 D.

Linoleum.

Machinery for Manufacturing Linoleum. Part first describes the hand manufacture of floor cloth, the methods of manufacturing linoleum, the proportion of ingredients used, the general arrangement of a typical factory, and gives illustrated description of some of the machinery used. 3000 w. Engng—Aug. 6, 1897. Serial. 1st part. No. 14609 A.

Portable Recorder.

A Portable Recorder for Tests of Metals. Gustavus Charles Henning. Read before the Iron and Steel Inst., Cardiff. Illustrated description of instrument designed by the author, its application and general utility. 2000 w. Ind & Ir—Aug. 6, 1897. No. 14601 A.

Pumping.

The Pump. J. W. Hughes. Lecture delivered before the plumbing class of the Montreal Council of Arts and Manufactures. Part first explains the principle of operation, and the action of the lift pump. 2000 w. San Plumb—Aug. 15, 1897. Serial. 1st part. No. 14659.

Refrigeration.

The Mechanical Production of Cold. J. A. Ewing. Howard lecture before the Society of Arts. General consideration of the thermodynamical basis of the processes, and of the action of refrigerating machines. Ill. 8000 w. Jour Soc of Arts—Aug. 13, 1897. No. 14813 A.

Sewing Machines.

Our Sewing Machines. From the *N. Y. Sun*. Interesting information of this industry, its extent, export trade, and changes wrought by the invention. 2800 w. Sci Am Sup—Aug. 7, 1897. No. 14472.

Technology.

Progress in the Domain of Mechanical Technology. (Fortschritte un Gebiete der Mechanischen Technologie.) A review, by Prof. Kick, of some recent advances in various lines, as shown in the expositions at Nuremberg and Budapest. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—July 30, 1897. No. 14728 B.

Vans.

Steam Road Vans. The first of a series of articles describing some of the best types of steam vans for common roads. Ill. 1300 w. Mach, Lond—Aug. 15, 1897. Serial. 1st part. No. 14865 A.

Water-Raising.

Water-Raising Appliances. Philip R. Björling. Part first gives illustrated description of the earliest mechanical contrivances. 2000 w. Mech Wld—Aug. 6, 1897. Serial. 1st part. No. 14616 A.

MINING AND METALLURGY.

COAL AND COKE.

Coal Formation.

Coal the Result of Flotation and Deposition in Lakes. Dr. Philippe Glangeaud, in *La Nature*. Recent important modifications in ideas of the manner in which coal was produced. 800 w. Min & Sci Pr—Aug. 14, 1897. No. 14686.

Coal Shipment.

The Application of Travelling Belts to the Shipment of Coal. Thomas Wrightson. Read at meeting of Iron and Steel Inst., at Cardiff. Describes the way the author proposes to overcome the difficulties which have prevented the belt from being applied to the shipping of coal. Discussion follows. 4500 w. Col Guard—Aug. 6, 1897. No. 14607 A.

Coal Washer.

The Wunderlich Coal Washing Apparatus. (Stromwäsche; Patent Wunderlich.) Describing an improved apparatus for washing coal as used at the mines in Kladno, Bohemia. 1500 w. 1 Plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 26, 1897. No. 14761 B.

Conveyer.

Coal Conveyer. An illustrated description of an improvement in coal conveying belting, patented by W. E. Kochs. 700 w. Eng, Lond—July 30, 1897. No 14514 A.

Explosions.

The Relation between Firedamp Explosives and Atmospheric Pressure. (Die Schlagwetter Explosionen mit Beziehung auf den Barometerstand.) The annual report for the Dortmund district for 1896, giving barograph curves and data of explosions, showing the relation between the relief of atmospheric pressure and the release of gas. 3000 w. 1 plate. Gluckauf—Aug. 7, 1897. No. 14743 B.

Production.

The Production of Coal in 1896. Report of he production in India, Spain, and the United States. 1600 w. Bd of Trd Jour—Aug., 1897. No. 14874 A.

Small Coal.

The Utilization of Small Coal. (Die Verwendung der Kleinkohle.) A discussion by Dr. Caspaar of the various methods of utilizing small

coal, taking into account the commercial conditions as they exists in Germany. Two articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 3, 17, 1897. No. 14762 E.

Spontaneous Combustion.

The Spontaneous Combustion of Coal. Discussion of paper by John L. Howard, read before the Pacific Coast Assn. 2200 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14635.

Spontaneous Ignition of Coal. John L. Howard. Read before meeting of the Pacific Coast Assn. Facts, theories, and statements bearing upon this subject, and gathered from various sources. 3300 w. Am Gas Lgt Jour—Aug. 9, 1897. No. 14531.

Submarine Workings.

Submarine Coal Workings in the North of Spain. Dach, in *Zeitschrift für das Berg-Hutten und Salinen-Wesen.* The method of working is described. 1100 w. Col Guard—July 30, 1897. No. 14520 A.

Tipplers.

Power-Driven Coal Tipplers. Illustrated description of an oscillating tippler which aims to avoid breakage and secure despatch. 1200 w. Col Guard—Aug. 20, 1897. No. 14928 A.

Victoria.

Systems of Coal Mining in Victoria. James Stirling. From the annual report of the Secretary for Mines, Victoria. The different systems used are described. 1100 w. Am Mfr & Ir Wld—Aug. 27, 1897. No. 14959.

GOLD AND SILVER.

Assaying.

Gold and Silver Assaying at Guanajuato, Mexico. W. N. Cummings. Description of a crucible used, which commends itself for the large number of fusions that can be made at once, the celerity and fuel economy. Ill. 500 w. Eng & Min Jour—Aug. 28, 1897. No. 14952.

Chlorination.

The Chlorination Process. Charles P. Williams. An outline description of the peculiarities of the various methods and appliances. The chemical process, the varieties of ores to which it is applicable, the method of treatment and how the process accomplishes the desired results. 4000 w. Col Eng—Aug., 1897. No. 14493 C.

Coolgardie.

The Gold Fields of Coolgardie. (Ueber die Gold Lagerstätten von Coolgardie.) An account of the new gold fields of Coolgardie, in West Australia, by correspondence from Herr Gmehling. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 31, 1897. No. 14765 B.

Cyanid.

Liquation in Cyanid Bars. Dr. Stockhauser. Abstract of paper read at meeting of Chemical and Metallurgical Society of South Africa. Discussing the fact that alloys of gold and silver with base metals do not solidify homogeneously, and that therefore errors may be made in assaying and sampling. Also discussion. 1500 w. Aust Min Stand—June 17, 1897. No. 14454 B.

Roasting Previous to Cyaniding. Wallace Macgregor. Presents the advantages of this method in certain cases, and gives suggestions. 1000 w. Eng & Min Jour—Aug. 14, 1897. No. 14643.

Successful Cyaniding. Illustrated description of the process as applied at the United Pyrites Works, Bendigo. 1600 w. Aust Min Stand—July 1, 1897. No. 14457 B.

Gold Belt.

Mines of the Gold Belt. W. H. Storms. Considers particularly the mines in the counties of Madera, Mariposa, Tuolumne, Calaveras, and Amador in California. 2000 w. Min & Sci Pr—July 31, 1897. No. 14490.

Gold Seekers.

The Gold Seeker in the West. Sam Davis. The life of the gold seeker, its privations and hardships, and the lessons taught. 3200 w. Chau—Sept., 1897. No. 14962 C.

Klondike.

British Yukon Mining Regions. An illustrated sketch of the district, its rich gold deposits, fuel supply, and other minerals; the difficulties to be met, routes, &c. 2800 w. Can Eng—Aug., 1897. No. 14555.

In the Far Northwest. Extracts from report of William Ogilvie, surveyor to the Dominion government, on the extent of the gold bearing section, its richn ss, &c. 2000 w. W Min Wld—July 31, 1897. No. 14427.

Ontario and Alaska. Information in regard to the prospectus of the Sault Ste. Marie and Hudson's Bay Railway Co., which proposes not only to reach the Klondike, but to open up the the lands which lie in the basin of the Mackenzie river. Map. 1200 w. Can Eng—Aug., 1897. No. 14553.

The Alaska Gold Field. Russell L. Dunn. Discussion of this field with conclusions. The placers are believed to be derived from erosion of gold bearing lodes, the richness of the Klondike placer is likely to be equaled by other discoveries, and the conditions are different from other mining regions. Also editorial. 4500 w. Min & Sci Pr—Aug. 7, 1897. No. 14572.

The Geological Survey's Expedition to the Yukon in 1896. Harold B. Goodrich. An interesting account of the journey from Juneau to the interior. 2400 w. Harper's Wk—Aug. 14, 1897. No. 14565.

The Gold Fields of Klondike and the Yukon Valley. Harold B. Goodrich. Methods of mining pursued in Alaska, and the necessity of improvement in ways of getting to the gold district. Ill. 3600 w. Eng Mag—Sept., 1897. No. 14904 B.

The Klondike Mining-Camp. Accounts by George Hamlin Fitch and by C. A. Snowden, with illustrations. Gives particulars of the discovery of these rich mines, the processes of mining, &c. 4800 w. Harper's Wk—Aug. 7, 1897. No. 14426.

The Klondike Placers. Information of the mode of laying out the claims, manner of working, with account of early explorations as pub-

lished in the *Canadian Engineer*. 1000 w. Eng. & Min Jour—Aug. 14, 1897. No. 14641.

The Yukon Goldfields. Extracts from Inspector Constantine's report to the government at Ottawa. On the richness of the deposits. 800 w. Aust Min Stand--July 1, 1897. No. 14458 B.

The Subsistence Question in the Klondike Region. Archibald A. Schenck. A letter arguing that under proper organization, and with proper effort, the winter may be the best time to make advancement into the Klondike region. The question of feed for the animals, where supplies must be transported is considered, and the construction of a wagon road recommended. 2400 w. R R Gaz—Aug. 20, 1897. No. 14802.

The Yukon Gold Region. Cyrus C. Adams. Valuable information gained by a Canadian surveyor, relating to important finds in the Klondike and other Yukon regions, routes, &c. Map & Ills. 1600 w. Harper's Wk—Aug. 14, 1897. No. 14564.

The Yukon Miner's Outfit. The outfit described is divided into clothing, subsistence, tools, and miscellaneous, and is prepared by one having a personal knowledge of the mining and climatic conditions. 1200 w. Min & Sci Pr—Aug. 7, 1897. No. 14573.

Transportation Routes to the Klondike. A summary of the reported routes existing and projected. 1200 w. Ry Age—Aug. 6, 1897. No. 14538.

Yukon Gold Region. Canada's Mining Regulations. Copy of the regulations governing placer mining on the Yukon, issued by the Canadian Government. 3300 w. Cons Repts—Oct., 1897. No. 14857 D.

Low-Grade Ore.

A Plant for Parting Low-Grade Bullion. F. Gutzkow. Illustrated description of the plant used by the writer. 1500 w. Eng & Min Jour—Aug. 21, 1897. No. 14811.

Mining Low-Grade Gold Ores in Alabama. William B. Phillips. Information of Clay County, discussing whether there is enough paying ore to warrant extensive gold-mining operations. Ill. 1500 w. Eng & Min Jour—Aug. 14, 1897. No. 14642.

Pelatan-Clerici Process.

The Pelatan-Clerici Process at the De Lamar Mill, Idaho. D.B. Huntley. A full description of the process aiming to correct wrong impressions, and to answer queries. Ill. 1600 w. Eng & Min Jour—Aug. 7, 1897. No. 14532.

Placer Mining.

Pointers on Placer Mining. Discusses the problems presented to the placer miner, and a few of the difficulties. 1400 w. Min Ind & Rev—July 29, 1897. No. 14432.

Prospecting.

Prospecting. Arthur Lakes. Extract from an instructive lecture recently delivered before the Miners' National Bureau, of Denver, Col., describing the formations most likely to be productive. 2300 w. Col Eng—Aug., 1897. No. 14495 C.

Scientific Prospecting. Thomas Smith. Part first calls attention to misleading teachings of geologists, and gives some directions based on facts found in the camp under investigation. 1500 w. Min & Sci Pr—Aug. 21, 1897. Serial. 1st part. No. 14916.

Slimes.

The Treatment of Slimes. Arthur J. Chappell. Describes method of treatment found successful; claiming the advantages of efficiency, cheapness and freedom of user. Consists in agitation and precipitation of the slimes, and the drawing off of the solution from the top. 600 w. Aust Min Stand—June 24, 1897. No. 14455 B.

Tasmania.

Scamander Mining District, Tasmania. J. Harcourt Smith. Report of the geological surveyor, pronouncing the prospects encouraging. 1300 w. Aust Min Stand—July 8, 1897. Serial. 1st part. No. 14509 B.

IRON AND STEEL.

Aluminum.

Aluminum in Steel. A. E. Hunt. From a paper entitled "The Utilization of Aluminum in the Arts," contributed to the *Aluminum World*. Reviews the special advantages to be gained by its use in steel manufacture. 2000 w. Ir Age—Aug. 5, 1897. No. 14438.

Analysis.

A Spectrographic Analysis of Iron Ores and Associated Minerals. W. N. Hartley and Hugh Ramage. Brief report of results in examination of the spectra of the flame from the converter used in the basic Bessemer process, and investigations of a large number of iron ores. 700 w. Ir & Coal Trds Rev—Aug. 13, 1897. No. 14820 A.

Armor.

See same title under Marine Engineering.

Carbon.

Recent Investigations in Refining, and in the Modifications of Carbon by Heating. (Neuere Arbeiten über Glühfrischen und die Veränderungen der Kohlenstoff-formen beim Glühen.) Discussing the formation of carbon in iron, either as free graphitic carbon or as carbid of iron. 6000 w. Stahl und Eisen—Aug. 1, 1897. No. 14754 D.

The Determination of Carbon as Hardening and as Carbid. (Bestimmung von Härtungs- und Carbidkohle.) A discussion by von Jüptner, of the various forms of combined carbon, and its influence on iron and steel. 7000 w. Stahl und Eisen—July 15, 1897. No. 14750 D.

Chrome Ore.

Chrome Ore. M. A. Clouet. Translated from the French. Where found, analyses from various localities, and the character of the surrounding strata are given in part first. 1000 w. Am Mfr & Ir Wld—Aug. 6, 1897. Serial. 1st part. No. 14542.

Cyfarthfa Works.

The Iron and Steel Institute. An account of two excursions, one in Old Dowlais, and the other to the Cyfarthfa Iron and Steel Works, with

historical account of the latter which are especially interesting because of their antiquity. 4800 w. Eng, Lond—Aug. 20, 1897. No. 14932 A.

Export Iron.

Southern Export Iron. William B. Phillips. The importance of the question of composition in connection with iron to be exported, urging great care in grading. 1300 w. Ir Trd Rev—Aug. 26, 1897. No. 14913.

Galvanometers.

See same title under Electrical Engineering, Miscellany.

High Grade Steel.

High Grade Steel. J. C. Danziger. Briefly reviews the leading processes, and the means of varying the physical properties. 5000 w. Jour Assn of Engng Soc—July, 1897. No. 14623 C.

Hungary.

The Iron Industry of Hungary. David A. Louis. Read before the Iron and Steel Inst., Aug., 1897. A review of the production of recent years, with information of the leading companies, &c. Ill. 7000 w. Col Guard—Aug. 13, 1897. No. 14839 A.

Iron Melting.

Wrought Iron Melting in a Coke Hole. C. Vickers. A record of experiences. 1300 w. Ir Age—Aug. 19, 1897. No. 14682.

Iron Ores.

Development of Lake Superior Iron Ores. D. H. Bacon. Read before the Am. Inst. of Min. Engs., Tower, Minn. A short résumé of what has been done in this industry. 1300 w. Ir Trd Rev—Aug. 12, 1897. No. 14617.

Martin Process.

Notes on the Martin Process. (Verchiedenes über Martinofenvetrieb.) A discussion of Herr Springorum's report at the convention of the Eisenhüttenleute, upon the open hearth steel process, treating of details of performance during the past year. 5000 w. Stahl und Eisen—Aug. 1, 1897. No. 14753 D.

Metal Mines.

Characteristic American Metal Mines. Horace V. Winchell. Describing the Mines of the Minnesota Iron Company. Ill. 4000 w. Eng Mag—Sept., 1897. No. 14899 B.

Microsopy.

Microscopy and Practice. Extracts from an article published in *Stahl und Eisen*. Prof. Ledebur considers the probability of the microscope being employed as a regular adjunct to every steel and iron works. 1000 w. Ir Trd Rev—Aug. 26, 1897. No. 14912.

Molybdenum Steel.

Certain Properties of Molybdenum Steel. W. v. Lipin, in *Stahl und Eisen*. Compares molybdenum steel with wolframium steel and studies the treatment and effects. 600 w. Am Mfr & Ir Wld—Aug. 20, 1897. No. 14843.

Passive Iron.

Passive Iron. James S. de Benneville. Read before the Iron and Steel Inst., Cardiff. It is proposed to follow the history of this question as developed in the researches of successive investigators; to try and trace the connection as showing progress of the central idea; and to consider the condition of the reagent in which passivity was secured. Part first is largely historical. 2800 w. Ind & Ir—Aug. 6, 1897. Serial. 1st part. No. 14600 A.

Phosphorus.

The Determination of Phosphorus in Iron and Steel. (Die Phosphor Bestimmung in Stahl und Eisen.) A discussion by Herr Leopold Schneider, of the Molybdate method of determining phosphorus and of the requisite conditions for obtaining reliable results. Two articles. 6000 w. Oesterr Zeitschr f Berg-u-Hüttenwesen—June 12, 19, 1897. No. 14760 E.

The Influence of Phosphorus on Cold Short Iron. (Der Einfluss des Phosphors auf Kaltbruch.) A valuable paper by von Jüptner, giving analyses and tests, and discussing the various forms in which phosphorus appears in combination. 5000 w. Stahl und Eisen—July 1, 1897. No. 14746 D.

Rails.

High Carbon and Special Steels in Rails. G. Whitefield Chance. Discusses the high carbon and other special steels and the effects of various elements in steel, chemical composition, heat and mechanical treatment. 4000 w. R R Gaz—Aug. 27, 1897. No. 14888.

Refining.

Thermo-Chemical Study of the Refining of Iron. Honoré Ponthière. The object of the paper is to explain, as far as possible, from existing analytical and thermo-chemical data, the phenomena which occur during a blow in a converter. 1200 w. Ir & Coal Trds Rev—Aug. 13, 1897. No. 14821 A.

Rod Mill.

The Twin Rod Mill at the Joliet Works of the Illinois Steel Company. Illustrated description of the largest rod mill in the world. 2000 w. Ir Age—Aug. 19, 1897. No. 14681.

Russia.

See same title under Economics and Industry, Miscellany.

Sardinia.

Discoveries of Iron Ore in Sardinia. (Neue Eisenerzfunde auf der Insel Sardinia.) Giving a geographical and geological account of the recent valuable discoveries in Sardinia. The ores are mostly magnetite and red hematite. 3500 w. Stahl und Eisen—July 1, 1897. No. 14747 D.

Steel Construction.

See same title under Civil Engineering, Canals, Rivers and Harbors.

Sulphides.

On the Diffusion of Sulphides Through Steel. E. D. Campbell. Read before the Iron and Steel Inst. Describes investigations of diffusion of sulphide of iron through steel. Experiments and results. 1500 w. Ind & Ir—Aug. 6, 1897. Serial. 1st part. No. 14599 A.

Sulphur.

The Determination of Sulphur in Iron. (Bestimmung des Schwefels im Eisen.) A discussion of Campredon's method by Herr W. Schulte, with illustrations of apparatus. 5000 w. Stahl und Eisen—June 15, 1897. No. 14744 D.

Testing.

The Results of Rupture Tests. (Ueber Ergebnisse von Zerreissversuchen.) Giving diagrams and tables of comparative tests made upon the same material in different laboratories. Sheet iron tests were made at Charlottenburg, Munich, Zurich and Essen. 3000 w. Stahl und Eisen—August 1, 1897. No. 14752 D.

Tin-Plates.

The Manufacture of Tin-Plates. George B. Hammond. Read before the Iron and Steel Inst., at Cardiff. Reviews the progress of tin-plate manufacture, and deals specially with the manufacture, commencing with steel bars. Ill. 5000 w. Col Guard—Aug. 6, 1897. No. 14608 A.

Tube Works.

The Alma Tube Works. An account of the works at Walsall, Eng., giving an abstract of a specification for solid-drawn plain steel tubes, showing how severe are the requirements. The process is described. 3000 w. Engng—July 30, 1897. No. 14504 A.

MINING.

Accidents.

Fellow Aid in Mining Accidents. G. W. King. Illustrated instructions for miners, enabling them to render intelligent aid in an emergency. 2200 w. Eng & Min Jour—Aug. 28, 1897. No. 14951.

Bureau of Mines.

A Chief of Bureau of Mines for Pennsylvania. A certified copy of the law providing for the new officer, and defining his duties. 2300 w. Col Eng—Aug., 1897. No. 14494 C.

Drills.

See same title under Mechanical Engineering, Miscellany.

Electric Mining.

The Application of Electricity to Mining and Quarrying. J. Warren. Briefly describes the general details of a system suitable for use in mining operations. 2500 w. Elec, Lond—Aug. 6, 1897. No. 14589 A.

Explosives.

Further Researches on the Action of Explosives upon Fire Damp and Coal Dust. (Weitere Versuche Betreffend das Verhalten von Sprengstoffen Gegenüber Schlagwetter und Kohlenstaub.) With analyses of various explosives and tabulated results of experiments. Two articles. 8000 w. Gluckauf—July 3, 10, 1897. No. 14739 D.

High-Grade Blasting Gunpowder. A. F. Hargreaves. Read before the Mining Inst. of Scotland. Favorable to the use of gunpowder of a high standard and giving reasons why it should be placed on the list of permitted explosives. 1100 w. Col Guard—Aug. 20, 1897. No. 14930 A.

Magazines for Explosives in Coal Mines. Brief account of rules regulating the storage of explosives underground, especially in France. 1400 w. Eng & Min Jour—Aug. 28, 1897. No. 14950.

Report on the Explosives in Coal Mines Order, 1896. Two tables giving an abstract of the results of trials made. 700 w. Col Guard—Aug. 20, 1897. No. 14929 A.

The Danger of Ignition of Mine Gases by Explosives. (Ueber Gefahrlose Zündung von Sprengstoffen auf Schlagwetter Gruben.) Discussing the relative danger of various blasting powders in this respect, with especial consideration of the Westphalian coal mining district. 2500 w. Gluckauf—June 19, 1897. No. 14737 B.

Formulae.

Notes on Some Faulty Formulæ. H. W. Halbaum. The paper draws the attention of mining men to some few formulæ in current use which are either unnecessarily clumsy or misleading in many circumstances to which they are constantly applied. 5500 w. Col Guard—Aug. 13, 1897. No. 14837 A.

Mine Accounts.

Mine Accounts. J. Parke Channing. Analyzing the expenses of mine operation, and suggesting a method of recording them. 3700 w. Eng Mag—Sept. 1897. No. 14902 B.

Mine Regulations.

Additional Mine Regulations in the Breslau District. Changes, chiefly relating to ventilation and use of explosives. 1600 w. Col Guard—Aug. 13, 1897. No. 14838 A.

Mine Stock.

Mine Stock: Its Use and Abuse. Charles E. Bowron. Directions for proper stabling of the animals, whether beneath or above surface, their food, care and work. 1700 w. Tradesman—Aug. 1, 1897. No. 14433.

Ohio.

Ohio Mining in 1896. Information from the twenty-second annual report which has just been filed. 1200 w. Eng & Min Jour—Aug. 21, 1897. No. 14810.

Smokeless Powders.

Some New Features in Smokeless Powders and Their Ballistic Results. Hudson Maxim. Presents the advantages of the Maxim-Schüpphaus smokeless powder, with tables showing the results of firing with it. Ill. 5700 w. Eng, Lond—July 30, 1897. No. 14512 A.

Surveying.

Surveying Mining Claims. Charles Tappan. Describes the transit work and chaining, showing the accuracy of modern methods. 2000 w. Jour Assn of Engng Soc—July, 1897. No. 14724 C.

Underground Fire.

Underground Fire Attributed to Electric Conductors. From a communication to the *Annales des Mines* by M. L. Champy, after a

report by Bergrat J. Mayer. The special cause to which experts attributed the fire in the Hermenegilde pit of the Kaiser Ferdinand Nordbaku Collieries, the difficulties of the rescue, recommendations of precautionary measures, &c. 2000 w. Col Guard—Aug. 13, 1897. No. 14836 A.

MISCELLANY.

Aluminum.

The Utilization of Aluminum in the Arts. Alfred E. Hunt. Discusses the Use of Aluminum in the manufacture of steel ingots and castings, in cast iron, nickel aluminum, cooking utensils, in chemical laboratories, in surgical instruments and appliances, bicycle parts, lithographic work, &c. 12000 w. Jour Fr Inst—Aug., 1897. Serial. 1st part. No. 14445 D.

Determining Minerals.

A Critical Review of the Methods of Determining Minerals. Dr. Joseph W. Richards. Examines the two systems of mineral classification, and reviews the methods of identification, giving the directions as taught at the Lehigh University. 4000 w. Jour Fr Inst—Aug., 1897. No. 14448 D.

Kaolin.

Kaolin in Vermont. J. Nelson Nevius. Deposits found at South Wallingford, Vt. Ill. 800 w. Eng & Min Jour—Aug. 14. 1897. No. 14644.

Manganese.

Some of the Manganese Deposits of the Valley of Virginia. Charles Catlett. Describes the ores and the various deposits. 1800 w. Eng & Min Jour—Aug. 7, 1897. No. 14533.

Monazite.

Monazite from Idaho. Waldemar Lindgren. Report of the widespread occurrence of this mineral in the Idaho basin. 1100 w. Min & Sci Pr—Aug. 21, 1897. No. 14915.

Monazite. H. B. C. Nitze. This paper embodies the results, in somewhat condensed and rearranged form, of previous communications which have appeared in the Sixteenth Annual Report of the U. S. Geol. Survey, and in Bul. No. 3 of the North Carolina Geol. Survey. Describes the mineral, where found, on what its value depends and price. 2400 w. Jour Fr Inst—Aug., 1897. No. 14447 D.

Quarrying.

A New Method of Quarrying Without Explosives. (Enie Neue Vorrichtung zum Auffahren von Gesteinsstrecken ohne Schiessarbeit.) A combination of wedges and battering ram, the wedges being inserted in drill holes and spread by a ram until the rock is split. 2500 w. Gluckauf—July 31, 1897. No. 14742 B.

Tin.

The Malay Tin Industry. T. Flower-Ellis. Read at meeting of Chemical and Metallurgical Society of South Africa. Part first deals with the deposits, methods of mining, and methods of extraction. 2100 w. Aust Min Stand—July 24, 1897. Serial. 1st part. No. 14456 B.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Address.

Address of the President (T. R. Parker, of Napa, Cal.), Fifth Annual Meeting of the Pacific Coast Gas Association. A general talk on matters of interest. 3500 w. Am Gas Lgt Jour—Aug. 9, 1897. No. 14530.

Inaugural Address of A. Bell before the North British Association of Gas Managers. Treats of the education of the gas engineer, need for commercial methods in the industry, the relative merits of sulphate of ammonia and nitrate of soda, &c. 3500 w. Gas Wld—July 31, 1897. No. 14527 A.

South Metropolitan Gas Company. Brief account of the meeting giving an interesting address by the chairman, Mr. George Livesey, with short discussion and editorial. 5000 w. Jour Gas Lgt—Aug. 17, 1897. No. 14872 A.

Accounts.

The Uniformity of Gas Accounts. C. O. G. Miller. Read before the Pacific Coast Gas Assn. The manner of keeping a record of the business is discussed. 3800 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14814.

Acetylene.

A Description of Acetylene Gas Plant. C. B. Outon. Describes an apparatus of the writer's construction which has recently been erected at one of the Great Southern and Western Railway stations and used with success. Read before the North of Ireland Assn. of Gas Managers. 700 w. Gas Wld—Aug. 14, 1897. No. 14848 A.

Illumination of College Buildings by Acetylene. Orrin E. Dunlap. Brief account of the adoption of this system of lighting by the Niagara University and Seminary of Our Lady of Angels. Ill. 450 w. W Elec—Aug. 21, 1897. No. 14835.

Consumption.

Ways and Means of Increasing Gas Consumption. H. Pooley. Read before the meeting of the North British Assn. Treats the subject with reference to the relation between manufacture and consumption, and with regard to the creation of an additional demand. 3000 w. Gas Wld—July 31, 1897. No. 14528 A.

Fuel Gas.

A Comparison of Fuel-Gas Processes. F. L. Slocum. Extracts from a paper read before the New York section of the Society of Chemical Industry. Discusses coal gas production by distillation, including bye-products, ovens, bituminous coal, water-gas producers, and producers of the Mond and Siemens type. 3300 w. Jour Gas Lgt—Aug. 17, 1897. No. 14871 A.

Gas Uses.

The Extending Use of Gas in Industrial Operations. Frederick H. Shelton. Describing the different kinds of commercial gas and their applications in manufacturing. 4200 w. Eng Mag—Sept., 1897. No. 14906 B.

Gas Works.

The Amsterdam Gas Works. Henry H. Salomons. Read before the Incorporated Institution of Gas Engineers. Descriptive. 4000 w. Am Gas Lgt Jour—Aug. 9, 1897. No. 14529.

Manufacturing.

Reminiscences of Gas Manufacturing and Kindred Matters. F. H. Eichbaum. Personal experiences, with brief discussion. Read at annual meeting of Pacific Coast Assn. 3400 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14636.

Municipal Control.

Municipal Control. C. W. Quilty. Read before the Pacific Coast Gas Assn. A legal, commercial, and political review of the question of municipal ownership. 3500 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14815.

Natural Gas.

Changing a Coal Gas System to the Use of Natural Gas. John Kempf, Jr. Read before the Pacific Coast Assn. An account of work at Salt Lake City, with discussion. 2400 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14639.

Oxygen.

The Estimation of Oxygen in Coal Gas. Presents the need of a rapid method of more accurately determining oxygen, and describes the method of Dr. Otto Pfeiffer, of Magdeburg. 2000 w. Jour of Gas Lgt—Aug. 17, 1897. No. 14869 A.

Purifying.

The Best and Most Economical Means of Purifying Gas. D. M. Nelson. Abstract of paper read before the North British Assn. of Gas Managers. Claiming that lime used in conjunction with oxid of iron was the best and most economical means of purifying gas. Short discussion. 3000 w. Gas Wld—Aug. 7, 1897. No. 14603 A.

Recuperator Benches.

Recuperator Benches for Coke and Coal Firing. Daniel R. Russell Read before the Pacific Coast Assn. Explains the conditions requisite for the installation of semi-recuperator benches, and their operation, giving a table of comparative results. Discussion. 3800 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14817.

Retorts.

A Short History of a Long Life. C. M. Converse. Discusses the length of life of a bench of clay retorts. Read before the Pacific Coast Assn. 2200 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14816.

Small Towns.

The Management of Lighting Plants in Small Towns. Thomas D. Petch. Read before the Pacific Coast Assn. Hints on the management, leakages, meter testing, purification, &c., with discussion. 3500 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14640.

Water Gas.

Lecture on Carburetted Water Gas. Ivison Macadam. Delivered at the annual meeting of the North of Ireland Assn. of Gas Managers. Explains the reactions necessary in the production, describes plant and its working and discusses a few of the advantages. 2800 w. Gas Wld—Aug. 21, 1897. No. 14937 A.

The Dellwik Water Gas Process. The substance of an interesting pamphlet by Dr. E. Fleischer, with special reference to the relation between the yield of gas and the extent to which the proportion of carbonic acid is pushed up in the blast gases. 3500 w. Gas Wld—Aug. 7, 1897. No. 14602 A.

Water-Gas as an Illuminant. Hugo Strache. Discussion of water-gas for lighting purposes, the recent improvements, safety burners, and other appliances. 3000 w. Pro Age—Aug. 16, 1897. No. 14651.

Welsbach.

Incandescent Gas and Electric Lighting: A Comparison. W. W. Gillespie. Claims superiority of the Welsbach incandescent gas light over other methods and suggests means of extending its use. Also discussion. 3000 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14638.

The Welsbach Light. G. I. Kinney. Read before the Pacific Coast Assn Details in regard to the installation of this light, that the writer has found important for its successful use. 1500 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14637.

SEWERAGE.

Drainage.

The Composition of Drainage Water. (Sur la Composition des Eaux de Drainage.) Showing the proportion of nitrogenous constituents and giving a discussion of the fertilizing value. 2500 w. Comptes Rendus—July 26, 1897. No. 14712 B.

Sewage.

Sewage Filter Beds at Paris, Tex. Information regarding the first sewage purification plant in the south. Ill. 1100 w. Eng News—Aug. 12, 1897. No. 14590.

The Liernur Exhaust System. (Le Système Aspirateur Liernur.) Describing the details of the installation of the Liernur pneumatic system of sewage removal at Trouville-sur-mer. 2500 w. La Revue Technique—July 25, 1897. No. 14702 D.

STREETS AND PAVEMENTS.

Asphalt.

Tests of Artificial Asphalt. (Prüfung von Künstlishem Asphalt.) Data of tests made at the Royal testing Laboratory at Berlin, with an account of methods, and tables of results. 4500 w. Mitt aus d Kg tech Versuchsaustalten—Part I. 1897. No. 14759 E.

Brick.

Vitrified Brick—Their Manufacture and Advantages as a Paving Material. J. W. Sibley. Read before the annual meeting of the Alabama Industrial and Scientific Society. Considers

only the vitrified brick made of shale. 1300 w. Brick—Aug., 1897. No. 14435.

Water Meter.

The "Venturi" Meter in Relation to the Measurement of Water in Large Mains. W. G. Kent. Read before the British Assn. of Water-works Engineers. A description of the instrument and its action. 2500 w. Jour Gas Lgt—Aug. 17, 1897. No. 14870 A.

Water Works.

Hereford City Waterworks. Illustrated description of the two engines substituted for two single cylinder condensing beam engines which previously did the work, and the economy resulting. 1500 w. Eng, Lond—July 30, 1897. No. 14517 A.

The City of Birmingham Corporation Water-Works. Henry Davey. Read before the Inst. of Mech. Engs. Information of the supply, reservoirs, steam pumps, cost of pumping, &c., with other matters of interest. 2700 w. Eng, Lond—July 30, 1897. No. 14519 A.

The Torquay Water-Works. W. Ingham. Read before the British Assn. of Water-Works Engs. An abstract of paper and discussion. Deals with the watersheds, mains, storage cisterns, &c. 3300 w. Jour Gas Lgt—Aug. 10, 1897. No. 14684 A.

Water-Works of Camden, N. J. Describes the artesian well system. 1500 w. Fire & Water—Aug 21, 1897. No. 14809.

MISCELLANY.

Garbage.

Garbage Collection and Disposal at Halifax, Nova Scotia. Instructions to householders, and specifications under which the contract for removal was awarded. 2200 w. Eng News—Aug. 19, 1897. No. 14696.

See same title under Electrical Engineering, Lighting.

The Utilization of New York Garbage. An illustrated description of the plant on Barren Island for the disposal of garbage. 1600 w. Sci Am—Aug. 14, 1897. No. 14567.

Sanitation.

The Sanitation of Small Towns. (Abfuhr der Abfallstoffe, &c., in Mittler und Kleineren Städten.) A discussion of this important subject by Baumeister Schmick, of Frankfurt a. M. 6000 w. Gesundheits Ingenieur—July 31, 1897. No. 14784 B.

Tenements.

See same title under Architecture and Building, Miscellany.

Wastes.

Disposal of the Wastes of New York City. Illustrated account of the arrangements for the disposal of paper and refuse. 1600 w. Sci Am—Aug. 28, 1897. No. 14863.

Wood Pavement.

Street Wood-Pavement in Paris. Report of the high favor in this city, discussing the kind suitable for street paving; the qualities desirable, accounts of tests made, and much other information. Ill. 13000 w. Ap. Series of Ind Forester—Part I. No. 14679 D.

WATER SUPPLY.

Construction.

Faulty Construction in Water Works Plants.—Its Effects upon Fire Departments and Cost of Insurance. William L. Cameron. Read at covnention of American Water Works Assn., at Denver, Colo. Briefly reviews some of the causes of poor construction. 1100 w. Fire & Water—Aug. 7, 1897. No. 14549.

Corrosion.

The Removal of Internal Corrosion from the Mains of the Kendal Water-Works. T. N. Ritson. Read before the British Assn. of Water-Works Engineers. An abstract of the paper and discussion. Describes the writer's experiences in the scraping of the mains. 3300 w. Jour Gas Lgt—Aug. 3, 1897. No. 14570.

Filtration.

Experiments in Water Filtration at St. Louis. Information in response to request, with copy of report of John F. Wixford, chemist of the water department. 2300 w. Munic Engng—Aug., 1897. No. 14449 C.

Hydrodynamics.

See same title under Mechanical Engineering, Power and Transmission.

Pumping.

Pumping Machinery. Alfred Fowler. Abstract of paper read before the British Assn. of Water-Works Engs. Describes a plant that has replaced an old Cornish engine at the Everton pumping station of the Liverpool Corporation. 1600 w. Jour Gas Lgt—Aug. 10, 1897. No. 14685 A.

Recorders.

Electrical Water-Level Recorders, and Their Use in Connection with Water-Works. W. Coles Finch. Abstract of a paper read before the British Assn. of Water-Works Engs. Illustrated description of the instrument, with the conclusions that beside the purpose for which it was intended it can be used for detecting and locating waste, for indicating the variations of level in wells, and for testing the yield. 1600 w. Elec Eng, Lond—Aug. 6, 1897. No. 14598 A.

Signalling Gear.

See same title under Marine Engineering.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

Construction.

Current Railway Construction. Reviews the most important works now pending in connection with British railways. 2000 w. Engng—Aug. 20, 1897. No. 14922 A.

The Strong Compound Balanced Locomotive.

Illustrated description with dimensions. 1700 w. Eng News—Aug. 19, 1897. No. 14698.

Mail Catcher.

Railway Mail Catcher and Delivery Devices. An illustrated description of the Fleming mail catcher, one of three devices tested and approved by the Post Office Department at Washington, D. C. 1000 w. Sci Am—Aug. 14, 1897. No. 14566.

Private Cars.

Private Cars. Duane Doty. Illustrated description of the car "Ellsmere," with remarks defending the practice of using private cars. 1800 w. R R Car Jour—Aug., 1897. No. 14544.

Wheels.

Wheel Mounting and its Relation to the Wheel Gage. Edward Grafstrom. Calls attention to a defect in Rule 3, of the new M. C. B. code. Ill. 1200 w. Aug. 27, 1897. No. 14889.

MAINTENANCE OF WAY.

Drawbridge.

Drawbridge Over Tallahatchie River—Yazoo & Mississippi Valley R. R. Illustrated description of a pivot drawbridge. 1600 w. Ry Rev—Aug. 28, 1897. No. 14957.

Niagara Bridge.

See same title under Civil Engineering, Bridges.

Rails.

See same title under Mining and Metallurgy, Iron and Steel.

Roadbeds.

Dustless Roadbeds. Theory and practice in the use of oil coated ballast as a dust preventive on the Pennsylvania road. Apparatus used is illustrated. 1300 w. Ry Age—Aug. 6, 1897. No. 14539.

Standards.

Value of Standards for the Maintenance of Way and Structures. W. G. Curtis. Arguing for the use of standard methods, and giving illustrations of some of the recent standards of the Southern Pacific Co. 1200 w. Ry Mag—July, 1897. No. 14657 C.

Station.

New Passenger and Freight Station at Montgomery, Ala.; L. & N. R. R. Illustrated description of arrangement and design. 1400 w. Eng News—Aug. 19, 1897. No. 14694.

Union Passenger Station at Springfield, Illinois. Illustrated description of a commodious and beautiful station to be built within the present year. 1000 w. Ry Rev—Aug. 14, 1897. No. 14663.

Tracks.

Chicago Track Elevation. Plan and profile of the work to be done this year by the Chicago & Northwestern Railway and the Pittsburg, Cincinnati, Chicago & St. Louis Railway jointly in elevating the tracks running south in Rockwell Street from the Galena Division. 700 w. R R Gaz—Aug. 13, 1897. No. 14584.

Track Elevation in Rockwell Street, Chicago. Description, with map of tracks, of the most expensive piece of track elevation for the distance, yet undertaken in Chicago. 2000 w. Ry Rev—Aug. 21, 1897. No. 14851.

Victoria Bridge.

See same title under Civil Engineering, Bridges.

TERMINALS AND YARDS.

Switches.

Electro-Pneumatic Push-Button Machine in the Pennsylvania Yards at Altoona, Pa. Illustrated description of plant in the distribution yard of the Pennsylvania Railroad at Altoona. The device is intended for work where interlocking is not required, but where a large number of movements must be performed in rapid succession. 1000 w. Ry Rev—Aug. 28, 1897. No. 14958.

TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list with classified summary. 3200 w. R R Gaz—Aug. 13, 1897. No. 14585.

Earnings.

Continued Improved Railway Earnings. Report of prosperous business on all roads except soft coal carriers, with comparative tables showing increases and decreases of 118 railroads. 2500 w. Bradstreet's—Aug. 14, 1897. No. 14613

Net Railway Earnings. Report for second quarter of the present year showing slow, but gradual improvement. Also tables of comparison. 2500 w. Bradstreet's—Aug. 21, 1897. No. 14807.

English Railways.

The Home Railway Half-year. Report of results of the half-year's workings of the principal English railways, showing general prosperity. 3000 w. Trans—Aug. 13, 1897. No. 14842 A.

Fast Trains.

A Very Fast Regular Train. Report of the excellent time made between Philadelphia and Atlantic City, on the Philadelphia and Reading. 500 w. R R Gaz—Aug. 13, 1897. No. 14586.

Gradients.

The Influence of Gradients on Speeds and Loads. Instructive statement of results in the running of two test trains on the Midland, on the Eastern, and on the Orange Free State Northern, with the object of ascertaining the actual and relative cost of haulage, as well as the cost of return empties. Tabulated statements are given. 1500 w. Engng—Aug. 13, 1897. No. 14826 A.

Train Services.

The Summer Train Services. Charles Rous-Marten. Comment on the marked retrogression, so far as speed goes, on the English railways. No such records as were made a year ago are shown though the time is better than before the

" race." Also calls attention to novelties on the different roads. 2000 w. Eng, Lond—July 30, 1897. No. 14513 A.

MISCELLANY.

Air-Brake Instruction.

A Model Air-Brake Instruction Room. Brief illustrated description of the new and complete instruction equipment of the St. Paul and Duluth Road. 1200 w. Ry Age—Aug. 20, 1897. No. 14819.

China.

The Actual Railway Situation and the Alleged Opportunities for American Engineers in China. Andrei Kimta. A full explanation of the situation. Conditions not promising for Americans. 2400 w. Eng News—Aug. 5, 1897. No. 14488.

Counterbalancing.

Locomotive Counterbalancing and its Effects. A. H. Angier. Translated from the French as published in the *Revue Generale des Chemins de Fer.* A study of the problem for the sake of substituting rational methods for the arbitrary system in actual use as stated by the author. 3000 w. R R Gaz—Aug. 20, 1897. Serial. 1st part. No. 14804.

Curves.

The Construction of Transition Curves for Railways. (Zur Construction der Uebergangsbögen bei Eisenbahngeleisen.) A mathematical discussion by Herr Alfred Birk, of the advantages of the lemniscate of Bernoulli as a figure for railway curves. Tables are given, simplifying the application of the curve to practice. 10,600 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14734 D.

Equatorial Africa.

The Railways of Equatorial Africa. Names the most important systems constructed, in course of construction, or projected in the African continent, and gives interesting information relating to them. 3000 w. Bd of Trd Jour—Aug., 1897. No. 14875 A.

India.

The Railways and Trade in India. Discusses the decrease caused by the famine and plague. The report of passenger traffic is generally favorable. 1600 w. Engng—Aug. 20, 1897. No. 14921 A.

Light Railways.

Light Railways in Belgium. A report of the remarkable progress of these lines. 2000 w. Eng, Lond—Aug. 6, 1897. No. 14605 A.

Railroad Statistics.

The World's Railroads. Editorial consideration of some of the details given in the *Archiv für Eisenbahnwesen*, published by the Prussian Ministry of Public Works. 1100 w. R R Gaz—Aug. 6, 1897. No. 14478.

Railroad Supplies.

See same title under Economics and Industry, Commerce and Trade.

Railway Operation.

Good Discipline as a Factor of Safety in Train Operation in England. Editorial on information given in the English Board of Trade report, showing that most accidents are the result of carelessness, and that the system of investigation and of discipline exert a powerful influence toward the prevention of accidents. 2800 w. Eng News—Aug. 12, 1897. No. 14595.

Russia.

The Railways of Russia. John H. Converse. Observations of an American, just returned from an extended European tour. 1000 w. Ry Age—Aug. 13, 1897. No. 14650.

Shops.

Chicago, Indianapolis, and Louisville Shops at La Fayette, Ind. Brief description, with engravings of some locomotive details used by this road which differ from general practice. 1200 w. R R Gaz—Aug. 6, 1897. No. 14475.

Soudan.

The Soudan Railroad. C. H. Grinling. An account of the railroad operations that will assist in following future developments. Historical review. 3500 w. R R Gaz—Aug. 13, 1897. No. 14583.

Washout.

The Railway Disaster at Kolomea. (Die Eisenbahm Katastrophe bei Kolomea.) A fully illustrated account of the disaster at Kolomea, Austria, in which a washout caused a bridge fall and train wreck; with photographs, and detail drawings. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14736 D.

Westinghouse Plant.

The Westinghouse Air Brake Company's Plant. A general account of the plant and of the processes employed in the manufacture of air brake equipment. 2300 w. Ry Age—Aug. 6, 1897. No. 14540.

Siberian Railway.

Structures on the Trans-Siberian Railway. Illustrated description of structures showing the substantial character of the work performed by the Russian government. 1100 w. Eng News—Aug. 12, 1897. No. 14591.

MAINTENANCE OF EQUIPMENT.

Baggage Cars.

Sanding the Ends of Baggage Cars. A. J. Bishop. A letter reporting satisfactory results on the Northern Pacific Railway, and the method used in sanding. 900 w. R R Car Jour—Aug., 1897. No. 14547.

Brakes.

Inside Hung Passenger Car Brakes. Report of discussion of this subject at the June convention of the Master Car Builders' Assn. 1800 w. R R Car Jour—Aug., 1897. No. 14545.

Instruction Car.

Air-Brake Instruction Car on the " Big Four Route." Illustrated description of the interior of this car. 1500 w. Sci Am—Aug. 21, 1897. No. 14669.

Air Brake Instruction Car; B. & M. R. R. Illustrated description of a car recently built by the Boston & Maine R. R. designed to give all information possible in the mechanism of the brakes. 900 w. R R Car Jour—Aug., 1897. No. 14546.

Locomotives.

American Locomotives for China and Japan. Illustrated description of some new Brooks engines for the orient. 1600 w. Ry Age—Aug. 6, 1897. No. 14541.

Eight-Wheel Passenger Locomotive—St. Lawrence & Adirondack Railroad. Illustrated description with general dimensions. 700 w. R R Gaz—Aug. 27, 1897. No. 14887.

Locomotives for the Waterford, Limerick and Western Railway. Illustrated description of four types of new engines, and tenders, and tank engines designed for work on a line with sharp curves and severe gradients. Dimensions are given. 900 w. Eng, Lond—Aug. 13, 1897. No. 14832 A.

Oil Burning Locomotives. Kirtland H. Wade. A consideration of the subject of liquid fuel, the vastness of the petroleum product, &c. with supplementary remarks by C. F. Lape. Ill. 3500 w. Ry Mag—July, 1897. No. 14658 C.

Speed of Rotation for Locomotive Engines. William F. M. Goss. On the importance of locomotives being designed with due regard to the performance of the engine under different speeds of rotation. 1400 w. Ry Mag—July, 1897. No. 14656 C.

Test of the Strong Balanced Locomotive at Purdue University. Abstract of the report of W. F. M. Goss, with discussion of the practice and principles. 3800 w. Sci Am Sup—Aug. 21, 1897. No. 14671.

The Purdue Tests of Strong's Balanced Locomotive. George S. Strong. A letter to the editor giving reasons for holding opinions differing from those expressed in a recent editorial in this paper. 1500 w. R R Gaz—Aug. 13, 1897. No. 14582.

STREET AND ELECTRIC RAILWAYS.

Accumulators.

See same title under Electrical Engineering, Power.

Brakeshoes.

A New Composition Brakeshoe. Describes the "Allen-Morrison Elastic" brakeshoe which has successfully withstood three months service tests on the South Elevated Railroad of Chicago. Also editorial. 1900 w. R R Gaz—Aug. 27, 1897. No. 14890.

Cables.

Novel Method of Cable Carrying. An illustrated account, from the *Journal* of Telluride, Colo., of twelve-thousand feet of tramway cable packed on mules. 350 w. Min & Sci Pr—Aug. 7, 1897. No. 14571.

Competition.

Suburban Competition. Charles J. Bates. Brief comparison of the economy of the central station with the locomotive as applied to suburban service. 1000 w. R R Gaz—Aug. 6, 1897. No. 14476.

Contact.

Single Acting Rail Contact. (Einseitig Wirkende Schienencontact.) An illustrated account of an improved electric contact attached to the rail and operated by wheel pressure, for the operation of bells, signals, &c. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—July 23, 1897. No. 14726 B.

Controllers.

Economy in Controller Handling. J. R. Cravathe. Discusses whether a rapid or slow advancement of the controller handle in starting a car is the more economical in practice. Favors slow acceleration. 900 w. St Ry Rev—Aug. 15, 1897. No. 14654 C.

Electric Car.

The Pyott Electric Street Car. Illustrated description of a novel departure in street car building, embodying a number of features effecting the ease and comfort of passengers. 700 w. Elec Eng—Aug. 12, 1897. No. 14562.

Electric Plants.

See same title under Electrical Engineering, Power.

Electric Traction.

Mechanical Features of Electric Traction. Philip Dawson. Read before the Inst. of Mech. Engs. Part first presents the importance of the subject and considers the outside work and rolling stock. 6500 w. Elec Eng, Lond—Aug. 6, 1897. Serial. 1st part. No. 14597 A.

Elevated Railways.

An Inquiry into Elevated Railway Equipment and Service. Editorial on the recent papers by S. H. Short and M. H. Gerry, Jr. 2300 w. Ry Rev—Aug. 14, 1897. No. 14664.

Expenses.

Standard Distribution of Street Railway Receipts and Expenses. Discusses the system adopted in the state of New York and recommends its adoption, with slight changes, as a standard to be used generally. 1200 w. St Ry Jour—Aug., 1897. No. 14461 D.

Fairmount Park.

The Electric Transportation System of Fairmount Park, Philadelphia. Illustrated detailed description of the methods by which this line has been constructed without interfering with the beauty or enjoyment of the park. 3000 w. St Ry Jour—Aug., 1897. No. 14459 D.

Feeders.

Feeder Lines. Gives facts regarding street railways operating under different conditions. 2200 w. St Ry Rev—Aug. 15, 1897. No. 14655 C.

Hannover.

Electric Street Railways in Hannover. (Ueber die Elektrische Strassen bahn in Hannover.) A paper before the Street Railway Association at Vienna by Friedrich Ross giving the results of experience both with trolley and storage battery systems. 7500 w. Mitt d Ver f d Ford d Local u Strassenbahnwesens—July, 1897. No. 14755 E.

Leipzig.

The Power Plant of the Leipzig Tramway System. (Die Einfuhrung des Elektrischen Betriebes auf der Grossen Leipziger Strassenbahn.) An excellent illustrated description of this fine new power house. 5000 w. Elektrotech Zeitscher—Aug. 5, 1897. No. 14788 B.

Locomotives.

Electric Locomotives. J. J. Swann. Deals principally with their use in elevated and surburban traffic, in which the motors are almost universally placed on the trucks. 1000 w. Mech Wld—Aug. 20, 1897. Serial. 1st part. No. 14907 A.

Melbourne.

The Great Street Railway System of Melbourne. F. W. N. King. Interesting account, with illustrations. 1500 w. St Ry Rev—Aug. 15, 1897. No. 14653 C.

Motive Power.

Electricity as a Motive Power on Elevated Railways. S. H. Short. Describes the performance of elevated trains with steam as a motive power, also the electrical equipment, with data of operation. Ill. 3800 w. W Elec—July 31, 1897. No. 14430.

Motor Cars.

Motor Cars vs. Electric Locomotives. William Baxter, Jr. The subject is discussed and the writer's opinion is that motor cars will be found to be most desirable for all purposes in work on the elevated roads. 4500 w. Elec Wld—July 31, 1897. No. 14453.

Multiple Unit System.

The Sprague Multiple Unit Electric Railway System for the Chicago Alley Elevated Railroad. Illustrated description of this new departure in electric propulsion, with consideration of its possibilities. 4000 w. Elec Wld—Aug. 7, 1897. No. 14535.

Narrow Gauge.

The Narrow Gauge Railway from Eaton Hall to Balderton. (Schmalspurige Kleinbahn von Eaton Hall nach Balderton.) An illustrated account of the Duke of Westminster's 15 inch gauge railway, mainly from English sources. 5000 w. Mitt d ver f d Ford d Local u Strassenbahnwesens—July, 1897. No. 14756 E.

Noise.

The Noise of Street Railways. (Das Geräusch der Strassenbahn.) A discussion of the causes of street railway noises and the methods of moderation, especially in the direction of smoother roadway and better rail joints. 2500 w. Deutsch Zeitsch f Elektrotechnik—July 15, 1897. No. 14780 B.

Paris Railway.

The Definite Project for the Metropolitan Railway of Paris. Notes on the methods adopted for building this system as abstracted from *Le Genie Civil*. 1300 w. Eng News—Aug. 26, 1897. No. 14892.

Storage Battery.

Englewood and Chicago Electric Storage Battery Road. George A. Damon. History and illustrated description of a road now attracting much attention, as it is the first one in this country to have an equipment especially designed for the use of this system. 4500 w. W Elect'n—Aug. 7, 1897. No. 14548.

Suburban Railroad.

The Suburban Railroad Company's System. Illustrated description of this electric railway system of lines, in and near Chicago. 2200 w. W Elec—July 31, 1897. No. 14428.

Subway.

The Glasgow District Subway. An illustrated account of the actual operation of this line. 3500 w. Ry Wld—Aug., 1897. No. 14612 A.

Summer Cars.

Some New Ideas in Elevated Railroad Equipment. Illustrated description of cars built for the South Side Elevated Co., of Chicago, which have met with great popularity. 1200 w. Ry Rev—Aug. 28, 1897. No. 14956.

Train Control.

The Sprague Multiple Unit System. Describes the main characteristics of train being experimentally operated on the track of the General Electric Company at Schenectady. 1600 w. St Ry Jour—Aug., 1897. No. 14463 D.

Tramways.

Electric Tramways with Stationary Accumulators. Ludwig Schröder. Abstract of paper read before the *Elektrotechnischer Verein*. Describes battery and its work. Also describes the Tettnang Electric railway, and the Remscheid. 2400 w. Elect'n—July 30, 1897. No. 14525 A.

Shall Tramways be Constructed and Operated by the Municipality? (Sollen Kommunen Strassenbahnen Bauen und Betreiben.) Discussing the question of Electric tramway franchises from the present German standpoint, showing the difficulties involved in municipal ownership. 3000 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14777 B.

The City of Leeds Electric Tramways. Illustrated detailed description of a successful municipal tramway. 8600 w. Ry Wld—Aug., 1897. No. 14611 A.

Trolley Decision.

The Van Depoele Trolley Decision. George H. Benjamin. The writer thinks the General Electric Company till controls the "so-called trolley invention." 1700 w. Elec Rev—Aug. 4, 1897. No. 14465.

Trolley Wires.

The Suspension of Trolley Wires for Electric Tramways. (Ueber die Aufhängung der Oberleitung bei Elektrischen Bahnen.) A mathematical discussion with special reference to the strains on the wires considered as catenaries. Two articles, 8000 w. Elektrotech Zeitschr—July 8 and 15, 1897. No. 14787 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Babcock & Wilcox, Ltd., London: 147 Queen Victoria street.=Excellently-arranged and handsomely-bound and-printed catalogue of "Accessories," containing 235 pages of text, illustrations, tables, and index. Section I gives general types of B. & W. boilers; Section II, furnaces for special fuels, smoke-prevention and forced-draught-apparatus, chimneys, and fire-brick; Section III, water-purifiers, boiler-cleaning apparatus, spare parts, and firing tools; Section IV, steam and exhaust pipes, valves, connections, heaters, feed-apparatus, condensers, superheaters, repair tools, etc. The catalogue is very full, and all parts are excellently classified, tabulated for size, and codified for ordering. Comparative tables of weights and dimensions facilitate the ready conversion of English data into continental equivalents.

The Detroit Lubricator Company, Detroit, Mich., U. S. A.=Catalogue (1897) of the various kinds and styles of sight-feed and other lubricators, and steam and hot-water valves, manufactured by this company.

H. W. Johns Manufacturing Company, New York.=Descriptive price-list (August 20, 1897) of asbestos goods.

W. G. Bagnall, Ltd., Stafford, England.=(*a*) Well-bound catalogue of 86 pages, illustrating and describing, with duties, dimensions, and prices, locomotives for all purposes and of all descriptions; also turn-tables, tipping wagons, gas, oil, and stationary engines, boilers, and light railway material of every kind. (*b*) Pamphlet illustrating light railways and equipment supplied by these works.

International Correspondence Schools, Scranton, Pa.=(*a*) Circular of information. (*b*) Blank form for application for enrollment.

Arthur Koppel, London, Eng., and Berlin, Germany.=Illustrated circular of information relating to the issuer's business as manufacturer of portable railway material and patent portable electric railway.

Webster Manufacturing Company, Chicago, Ill.=Catalogue No. XV. An elegant publication, illustrating and describing elevating and conveying machinery, gas engines, machinery for transmission of power and for handling all classes of material in grain elevators, flour mills, sugar refineries, oil mills, mines, and malt houses.

The British & Foreign Metaline Co., Dundee, Scotland.=Leaflets describing "Metaline," an anti-friction metal to be used in bushes and bearings without lubrication, and giving directions for its employment.

Clarke's Crank & Forge Co., Ltd., Lincoln, England.=Card picturing the "Libra" perfect-balance oil engine, and stating its merits and the size in which it is made. The engine is adapted to use on locomotive cranes.

Clayton & Shuttleworth, Lincoln, England.=(*a*) Illustrated catalogue "No. 96" of portable and fixed engines, boilers, and farm machinery; including thrashing machines, straw-cutters, stackers, straw-trussers, baling-presses, grinding-mills, etc. (*b*) Revised price-list of the firm's machinery of all kinds. (*c*) Pamphlet "1723" of "Accessible" centrifugal pumps. (*d*) Pamphlet "1761" of improved patent oil engines. All are well illustrated, with brief descriptions and full tables of sizes.

The Goulds Mfg. Co., Seneca Falls, N. Y., U. S. A.=Illustrated descriptive catalogue of efficient power-pumps for every service.

The Ball & Wood Company, New York.=Large, illustrated, descriptive pamphlet, setting forth advantages and merits of automatic cut-off steam engines manufactured by this company.

Gisholt Machine Company, Madison, Wisconsin, U. S. A.=Elegantly illustrated and printed descriptive catalogue (Catalogue H) of Gisholt lathes and Universal tool grinders.

W. Summerscales & Sons, Ltd., Keighley, England.=A handsome cloth-bound catalogue of 132 pages, devoted to modern high-class laundry machinery of every description. It is well illustrated and excellently indexed, and shows a remarkably full line.

Massachusetts Institute of Technology, Boston, Mass., U. S. A.=Programme of the courses of instruction, with a statement of the requirements for admission, and a list of officers.

The International Correspondence Schools, Scranton, Pa.=Pamphlet entitled "1,000 Testimonials from Students."

Powell & Brother, Boston, New York, Chicago, St. Louis, U. S. A.=Leaflet entitled "Coal Money Burned. Coal Money Saved. The Paul System" Sets forth the advantages of the "Paul system" of heating and drying by steam.

I. P. Frink, New York.=Leaflet setting forth the merits of Frink's patent reflectors for electric lights.

C. H. Haesler Company, Philadelphia, Pa., U. S. A.=Catalogue illustrating and describing portable pneumatic tools. The half-tone engravings illustrating applications of these tools to various kinds of work are particularly fine.

Watson, Laidlaw & Co., Glasgow, Scotland.=Two well printed catalogues, in stiff covers. (*a*) Hydro extractors, for drying textile materials of all kinds, as used in laundries, dye-works, etc. (*b*) Brass and copper heating coils, vacuum-pans, concentrators, stills, evaporators, etc., and gun-metal valves, cocks, lubricators, cups, and fittings. Also a handsome, cloth-bound, illustrated catalogue of machinery for the treatment of sugar after boiling, centrifugal machines, pug mills, breakers, coolers, conveying machinery, etc.; and small pamphlets of water-driven centrifugals and "Victoria" and "Empress" cream separators.

John Wild & Co., Ltd., Oldham, England = Pamphlet illustrating, listing, and pricing hauling and winding engines, steam engines, duplex and three-throw pumps, and vertical boilers.

J. H. Wilson & Co., Liverpool, England.=Illustrated descriptive catalogue of locomotive cranes, fixed, derrick, wharf, and coaling cranes, grab-dredges, steam winches, winding engines, and concrete-making machinery.

Wright's Patent Heater Condenser Co., Great George street, Chambers, Westminster, England. =Pamphlet on water-purification, treating of hard and soft water, and purification by chemical processes, and illustrating the Wright process as adapted to manufacturing and boiler plants.

Hyatt Roller Bearing Company, Harrison, N. J., U. S. A.=Illustrated catalogue and price-lists for 1897, of "Hyatt" flexible roller bearings.

Priestman & Company, Philadelphia, Pa, U. S. A.=Pamphlet containing an illustrated description of the "Priestman Safety Oil Engine," which uses common lamp oil for fuel, and setting forth at length the advantages of this simple motor.

American Radiator Company, Chicago, Ill., U. S. A.=Large quarto, elegantly printed, and illustrated descriptive catalogue of "Ideal" sectional portable, and brick set boilers, for steam and hot-water heating.

Drum Engineering Co., Bradford, England.= Pamphlet figuring, describing, and listing, with sizes and prices, the "Johnson's Patent Drum Pump" for gases, liquids, or semi-fluids. The pump has centrifugal motion, positive action, and is either for pressure or exhaust.

Glenboig Union Fire Clay Co., Ltd., Coatbridge, Scotland, office 48 W. Regent street, Glasgow.= Catalogue, with reports on Glenboig fire clay, extracts from authorities testifying to its merits, and many pages of perspective illustrations, in tint, showing shapes and dimensions of fire brick, tile, covers, glass house blocks, special bricks and blocks, retorts, pipes, traps, and connections.

Illinois Steel Company, Chicago, Ill., U. S. A. =Illustrated pamphlet, describing the "Steel" Portland Cement manufactured by this company from blast-furnace slag, stating buildings wherein this product has been used, and containing data of tests, with other information.

Pullman Sash Balance Company, Rochester, N. Y., U. S. A.=Eleventh Annual Catalogue. Illustrates and describes a number of novelties and specialties in the line of builders' hardware.

Grafton & Co., Bedford, England.=Price-list of steam cranes, from two to thirty-two tons capacity, with illustrations of machinery in actual service.

Edward G. Herbert, Manchester, England.= Leaflets illustrating and describing (*a*) the "Universal Truth Indicator," for testing whether surfaces of revolution are running true; (*b*) improved beam-trammels, adaptable to serve as inside or outside calipers; (*c*) steel cramps; (*d*) eccentric-grip vice dog; (*e*) Herbert's patent side cramp; (*f*) radial-slot face-plate dog; (*g*) breadth and turning gages; (*h*) adjustable screw packings.

Holden & Brooke, Ltd., Sirius Works, West Gorton, Manchester, England.=(*a*) Abridged catalogue of steam users' specialties. A handy pamphlet, convenient for the pocket or for filing, illustrating and describing steam dryers, anti-primers, steam traps, water-ejection and reducing valves, injectors, ejectors, thermo-regulators, circulators, equilibrium, back-pressure and foot-valves, strainers, etc. The cuts are so well lettered that the action and mode of connection of each device are apparent at a glance, and an adjoining table gives sizes, capacities, and prices. (*b*) A special pamphlet devoted to steam dryers and anti-primers.

Norton Emery Wheel Company, Worcester, Mass. U. S. A.=(*a*) Illustrated catalogue of the Norton emery and corundum wheels, emery wheel machinery, and specialties. (*b*) Two small pamphlets illustrating and describing the "Bath Indicator" for testing truth and alignment of machine parts.

The Westinghouse Machine Company, Pittsburg, Pa., U. S. A.=Pamphlet illustrating and describing the "Westinghouse" steam engine, and the details of its manufacture, as a business, from the selection of materials, up through the workmanship, testing, regulation, and sale, with an account of the different styles of engines made, and a statement of efficiency.

Todds & Stanley Mill Furnishing Company, and Todd Pulley and Shafting Works, St. Louis, Mo., U. S. A.=Price list of power-transmission machinery and furnishings.

Marshall, Sons & Co., Gainsborough, London, and Calcutta.=Illustrated catalogue and price-list of steam engines, boilers, and other machinery, including all ordinary types of engines, small and large, fixed and portable, horizontal and vertical, simple and compound, and of boilers, both separate and with engines.

Johnson & Phillips, Old Charlton, Kent, England.=(*a*) Pamphlet in stiff covers, with good line cut and half-tone illustrations, describing the "Sheba Electric Transmission of Power" for mining purposes in South Africa—about 600 h. p. for five miles. (*b*) A large series of well printed and well illustrated leaflets devoted to electric and other machinery manufactured by Johnson & Phillips, including direct current dynamos, alternators, transformers, lamps, and cable-laying machinery.

The Frictionless Engine-Packing Co., Ltd., Manchester, England.=Leaflets recommending "Karmal" and "Ogden's Patent Metallic" packings.

The J. W. Ruger Mfg. Co., Buffalo, N. Y., U. S. A.—Catalogue, illustrating and describing a line of gas engines manufactured by this company; with data of powers, speeds, dimensions, and weights.

Manlove, Alliott & Co., Ltd., Nottingham, Glasgow, London, and Manchester.=A collection of leaflets between stiff cloth covers, devoted to sugar machinery of every description, from cane mills to vacuum-apparatus and suspended centrifugals, as well as stationary and locomotive engines. The range covers about everything that could be needed on the plantation or in the refinery.

Pease's Tubular Construction Syndicate, Ltd., Stockton-on-Tees.=An originally-designed booklet devoted to iron-trough flooring, wide-span wood and iron floors, non-metallic portable houses and roofs, and tubular columns and fire-proof casing. Illustrated by sections and perspectives, showing construction and accompanied by blue-prints and data of tests.

BOOKS OF THE MONTH

William S. Hall, E. M., C. E., M. S., professor of technical mathematics in Lafayette College. Elements of the Differential and Integral Calculus, with Applications. D. Van Nostrand Co., New York, 1897. Cloth, $2.25.

Notwithstanding the existence of a great number of treatises in nearly every branch of mathematical science, and notwithstanding the fact that the principal branches of mathematics applicable to practical, experimental, and professional work long since reached a point beyond which they are not likely to be much further advanced, new treatises in these different departments are constantly making their appearance. For the most part they contain nothing new, except, perhaps, some modes of presenting to the minds of students difficult points, which methods the author, in his classes, has found valuable as aids in conveying a complete understanding of the subject. It may be admitted that, if such modes of presentation are really valuable, the fact justifies their publication. There is also a praiseworthy tendency among the teachers of mathematical science to increase the practical skill of students in its application by the presentation of numerous practical problems exemplifying the value of mathematical methods in engineering work. This feature is prominent in Prof. Hall's treatise. The method of limits is used for the demonstration of formulas for differentiation. The author deems this method more rigorous than the method of infinitesimals,—an opinion with which many will not agree. He also thinks it is more readily understood than the method of infinitesimals,—a view in which more will concur, but with which we are forced to differ. The comprehension of the true spirit of either method will depend much upon individual peculiarities of intellect, and the preference for one method over the other will generally be influenced by the experience of the student in his approach to the subject, the method used first being the one most liked. Another feature of Prof. Hall's treatise is the prominence given to the more important applications of the calculus; for example, the subjects of maxima and minima radius of curvature, etc. Chapter IX, on the evaluation of indeterminate forms, is an unusually clear exposition, all the more valuable from the large number of carefully-framed and -graded problems involving the presence and use of such forms. The chapter on maxima and minima also contains an unusually clear exposition of principles and a well-selected collection of problems showing the numerous and important applications of this method in mechanics and generally in the constructive arts. We are forced to the conclusion that this is an excellent book, prepared by a thorough teacher, and that it will rank among the best of modern textbooks.

Johnston's "Electrical and Street Railway Directory" for 1897. Containing lists of electric-light central stations, isolated plants, mining plants, street railways (electric, horse, and cable), telegraph companies, district messenger companies, telephone companies, manufacturers and dealers in electrical and street railway apparatus, machinery, and supplies. The W. J. Johnston Co., New York, 1897. Cloth, $5.00.

It scarcely needs saying that the purpose of this compilation is to collect and arrange in a convenient manner such information relative to electrical and street railways as will be useful to all who have, or desire to have, dealings or business connections with the individuals or corporations who carry on this kind of industry. A notice or review of such a book should, therefore, be directed to a statement of the degree of success which has attended the effort, and we are glad to be able to say that this book is rich in all the qualities which make such a work of reference desirable. In the first place, it is the only directory containing this information yet published in America; second, the information is thoroughly up to date; third, the arrangement and classification of the information is such as greatly to facilitate reference; and, fourth, the scope of the book includes not only the electrical and street railways

of the United States, but also those in Canada, Mexico, and Cuba, together with much other information indicated in the title. So far as we know, no other directory or directories now published could take its place. The names are arranged alphabetically, according to States, cities, and towns, and manufacturers are classified not only according to States, cities, and towns, but according to business, and also in an alphabetical or finding list. The names of managing officers, purchasing agents, superintendents, etc., of central stations and street railways are comprised in the vast amount of other useful information presented.

Tratman, E. E. Russell. Railway Track and Track Work. With more than two hundred illustrations. The Engineering News Publishing Co., New York, 1897. Cloth, $3.00.

It is believed that no other extant treatise on the subjects named deals with them so comprehensively and thoroughly as they are treated in Mr. Tratman's book. The author, a member of the American Society of Civil Engineers, and an associate editor of *The Engineering News*, has prepared the work especially for the use of railway engineers and road-masters. While this is the case, it is believed that the treatise can be made of service to superintendents and other operating railroad officials. The breadth of the work may be somewhat judged by a summary of its contents. Chapter 1 treats of the importance of the track, and its relations to traffic; chapter 2 treats of cross-sections; chapter 3 of ballast; chapter 4 of ties and tie-plates; chapter 5 of rails. In these chapters the different kinds of ballast, qualities of wood for ties, tie renewals, preservative processes, metal tie-plates, metal ties, history of railway rails, form of section, foreign rails, manufacture of rails, and the life and wear of rails are topics treated, these first five chapters occupying seventy pages. In chapters 6 and 7 rail fastenings and joints in all their variety, and switches, frogs, and switch-stands almost as numerous as fastenings and joints, are comprehensively discussed. Chapters 8 to 11 inclusive deal respectively with fences and cattle-guards, bridge floors, and grade crossings, track signs, tanks, and other track accessories. Chapters 12 to 18 inclusive treat of side tracks and yards, track tools and supplies, organization of the maintenance-of-way department, track-laying and ballasting, drainage and ditching, track-work for maintenance, gage, grade and curves. Chapters 19 to 22 inclusive cover track inspection and the premium system, switch work, bridge work and telegraph work, and general improvements. The remaining three chapters treat of handling and clearing snow, wrecking trains and operations, records, and reports. An appendix presents tables of standard track construction on fifty railways. A second appendix contains a table of train-speeds and distances run. We think this work deserves to, and will, take rank among standard technical railroad literature.

An Elementary Treatise on Heat and Heat Engines. By W. C. Popplewell. The Technical Publishing Co., Lim., Manchester.

It is not easy to write a treatise upon the subject of heat engines which shall be really elementary, for the very good reason that the subject is in itself advanced, and calls for advanced methods of treatment. Something more than a knowledge of elementary mathematics is needed to understand the language in which it must be written, and the expectation that thermodynamics may be taught in words of one syllable, so to speak, is certain to be disappointed.

However, the present work, which is the republication of a series of articles which have appeared in *The Practical Engineer*, fulfils its intention, in so far as it uses no more of mathematics than is absolutely necessary, and avoids as much as possible the too common tendency of writers on thermodynamics to assume a thorough knowledge of higher mathematics.

After treating of the general phenomena of heat, including its nature, and the methods of measurement, chapters are given on air and gas engines, followed by the thermodynamics of the steam engine. While there is nothing new either in the matter or in the general manner of its presentation, yet, as a whole, the treatise

as it stands is an acceptable exposition of the modern theory of heat and heat motors in language probably as clear and simple as possible in view of the nature of the subject; and it should prove useful to those students and professional men who have neither time or training to undertake the more formidable works of the great original investigators.

Graphische Logarithmen-Tafeln. Anton Tichy, Ober-Ingenieur der K. K. Oesterr. Staatsbahn. Wien, 1897.

This pamphlet demands attention from the fact that it adds another to the increasing list of attempts to substitute graphical for numerical operations whereever possible. Briefly, the book consists of a number of adjacent printed scales, consisting of graduations representing respectively the numbers from unity to 10,000 and their corresponding common logarithms. By looking for any number on the one scale its logarithm is found immediately opposite, or *vice versa*, and all the operations which are performed with a table of logarithms can be readily done in a similar manner by referring to these scales. The book also contains graphical or scale tables of logarithmic sines and cosines, as well as tangents and cotangents, these angular functions being given both for the centesimal and sexagesimal divisions of the degree. Since there are nine columns on a page and eleven pages of common logarithms, each page being about eight inches long, the scales correspond practically to a slide rule more than sixty-five feet long, and, in fact, logarithms can readily be taken out, in most cases, accurately to the fifth decimal place. The book can be used in many cases with almost the same facility as the slide rule, except that the arithmetical work of adding or subtracting the logarithms must be performed separately, involving the use of pencil and paper during the progress of a computation; while, especially in some of the later forms of circular slide rules, nearly all computations except those involving addition or subtraction can be performed continuously, no record being made until the final result is obtained. Herr Tichy's work is, however, interesting and valuable, especially as showing the growing tendency toward the use of graphical methods, and for many purposes it will be found convenient, and accurate enough for all practical purposes.

John Perry, M. E., D. Sc., F. R. S., professor of mechanics and mathematics in the Royal College of Science. The Calculus for Engineers. Edward Arnold, New York—London. 1897. Cloth, $2.50.

This book embodies the course of instruction in the calculus prescribed for the students of mechanics and electrical engineering in Finsbury Technical College. Perhaps in no field of engineering has the calculus proved more practically useful than in the field of electrical engineering. In a book specially designed for engineers one therefore expects much attention to be given to electrical problems, and this is the case in the book under notice to an extent entirely unprecedented, so far as we know. The mechanical applications are about equally numerous. The differentiation and integration of x^n, e^{ax}, and $\sin ax$ are dealt with chiefly for the reason—as the author tells us in the first paragraph of Chapter III—that, "unless one is really intending to make a rather complete study of the calculus, nothing further is needed. Our knowledge of these three functions is sufficient for nearly every practical engineering purpose." But for those who wish to go further Chapter III, which completes the treatise, deals with general differentiation and integration. Both the matter and method of this treatise command admiration, and we regard it as an important addition to any engineer's working library.

BOOKS RECEIVED.

Consular Reports, May, 1897. Commerce, Manufactures, etc. Government Printing Office, Washington, 1897. Paper.

Message of the Mayor, with the Annual Reports of the Officers, of Salt Lake City, Utah, for the year 1896. Published by authority of the City Council, Salt Lake City, 1897. Paper.

Eleventh Annual Report of the Commissioner of Labor, 1895-96. Work and Wages of Men, Women, and Children. Government Printing Office, Washington. 1897. Cloth.

Cain, William, Maximum Stresses in Bridges. D. Van Nostrand Company, New York. Stiff paper. 50 c.

Lülpke, Dr. Robert. The Elements of Electro-Chemistry, Treated Experimentally. Translated from the Second, Revised and Enlarged Edition, by MM. Pattison Muir, M. A. H. Grevel & Co., London. J. B. Lippincott Company, Philadelphia, Pa., 1897. Cloth, $2.50.

Hall, William S., E. M., C. E., M.S., Professor of Technical Mathematics in Lafayette College. Elements of the Differential and Integral Calculus: With Applications. D. Van Nostrand Company, New York, 1897. Cloth, $2.25.

Rafter, Geo. W. Water Supply and Irrigation Papers of the United States Geological Survey. No 3. Sewage Irrigation, Department of the Interior, Washington, D. C., 1897.

The Smoke Nuisance and its Regulation, with Special Reference to the Condition Prevailing in Philadelphia. Discussion at the Stated Meeting of the Franklin Institute, held May–June, 1897. Reprinted from the *Journal of the Franklin Institute*, Philadelphia, 1897. Paper.

Day, William C. The Stone Industry in 1896. Extract from the Eighteenth Annual Report of the Survey, 1896–97. Part V. Mineral Resources of the United States, Calendar year 1896, David T. Day, Chief of Division of Mineral Resources. Department of the Interior—U. S. Geological Survey, Charles D. Walcott, Director, Washington, D. C., 1897. Paper.

Import Duties of the United States. The Tariff Act Approved July 24, 1897, Commonly Known as "The Dingley Law." Fifty-fifth Congress, First Session. Bureau of American Republics, International Union of American Republics, Washington, D. C., U. S. A., Joseph P. Smith, Director. Bulletin No. 75, July, 1897. Wash. Govt. Printing Office, 1897. Paper.

Butte Free Public Library. List of Books for Engineers and Architects. Butte City, Montana, U. S. A., 1897. Paper, 25c.

Tenth Annual Report of the Board of Public Works, City of Duluth, Minn., for the Year Ending February 28, 1897.

Hawaii. Handbook No. 85 (August, 1897). Bureau of the American Republics. Joseph P. Smith, Director. Washington, D. C., U. S. A. 1897. Paper.

Exports Declared for the United States. Returns from Consular Districts for Quarter Ended March 31, 1897. Supplement to Consular Reports No. 203. August, 1897. Paper.

Starling, William. The Floods of the Mississippi River. Including an Account of Their Principal Causes and Effects, and a Description of the Levee System and Other Means Proposed and Tried for the Control of the River. With a Particular Account of the Great Flood of 1897. Reprinted from *The Engineering News*. The Engineering News Publishing Co., New York. 1897. Paper, 50 cents.

Annual Reports of the Civic Government of Halifax, N. S., for the Civic Year 1895–6.

Wood, A. H. Commissioner of Labor and Inspector of Mines of the State of Tennessee. Sixth Annual Report of the Bureau of Labor, Statistics and Mines to the Governor, and Fiftieth General Assembly of the State of Tennessee, 1896.

Benzenberg, G. H. Annual Report of the Board of Public Works of the City of Milwaukee for the Year Ending December 31, 1896. Paper.

Haldane, J. W. C. Railway Engineering, Mechanical and Electrical. Spon & Chamberlain, New York. 1897. Cloth. $6.

Municipal Council of Shanghai. Report for the Year Ending December 31, 1897, and Budget for the Year Ending December 31, 1897. Kelly & Walsh, Limited, Shanghai. 1897. Pa.

Report of the Massachusetts State Board of Health upon the Sanitary Condition of Canton, Sharon, Norwood, Dedham, Milton, and Hyde Park. Wright & Potter Printing Co. Boston. 1897. Cloth.

Shedd, J. Herbert. Annual Report of the City Engineer of the City of Providence, for 1896. Remington Printing Co., Providence, R. I. 1897. Paper.

Exports Declared for the United States. Returns from Consular Districts for Quarter Ended December 31, 1896. Government Printing Office, Washington, D. C. 1897. Paper.

Nitze, Henry, B. C., and Hanna, George B. Bulletin No. 3. of the North Carolina Geological Survey. Gold deposits of North Carolina. M. I. and J. C. Stewart, Winston, N. C., Public Printers. 1896. Paper.

Twenty-seventh Annual Report of the Board of Directors of the Lake Shore & Michigan Southern Railway Company for the Fiscal Year Ending December 31, 1896. Munhall Bros. Co. Cleveland, Ohio. 1897. Paper.

Twenty-fourth Annual Report of the Lowell Water Board to the City Council of the City of Lowell, Mass., and the Reports of the Superintendent of Water Works, and of the City Engineer, to the Water Board for 1896. Butterfield Printing and Binding Company, Lowell, Mass. 1897. Paper.

BOOKS ANNOUNCED.

Baldwin, W. J. Steam-Heating for Buildings or, Hints to Steam Fitters. Fourteenth edition, revised and brought up to date. J. Wiley & Sons, New York. 1897. Cloth. $2.50.

Crapper, Ellis H. Practical and Electrical Measurements. An Introductory Manual for Young Engineers and Students. The Macmillan Co., 1897. Cloth. 75 cents.

Johnson, J. B.. The Materials of Construction. A Treatise for Engineers on the Strength of Engineering Materials. J. Wiley & Sons, New York. 1897. Cloth. $6.

Speirs, F. W. The Street Railway System of Philadelphia: Its History and Present Condition. The Johns Hopkins Press, Johns Hopkins University, Baltimore, Md. 1897. Paper. 75 cents.

Wright, T. Wallace. Elements of Mechanics, Including Kinematics, Kinetics, and Statics, with Applications. D. Van Nostrand Co., New York. 1897. Cloth. $2.50.

IMPROVED MACHINERY

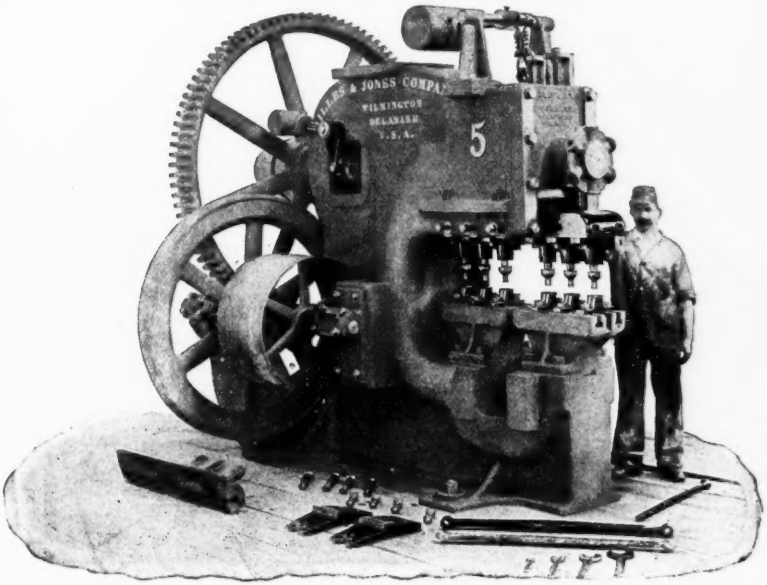
NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Structural-Iron Punch.

THE accompanying engraving illustrates a special construction of the regular structural-iron punch manufactured by Hilles & Jones Company, Wilmington, Delaware, U. S. A. The machine is specially intended for beam and channel work, for which classes of work its adaptability will clearly appear from the engraving and the description.

the floor space is economized as much as possible by bringing the pulleys alongside of the main frame, as will be noticed. There is an improved adjustable automatic stop working a three-jawed clutch as on the regular standard designs. Counterbalancing of the sliding head is accomplished through a spiral spring which takes the shock of punching.



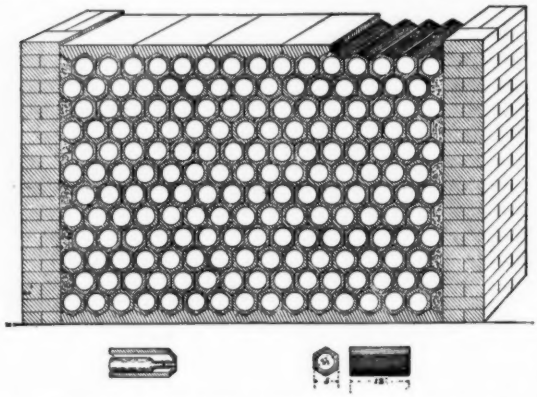
With this machine the range of punches—which are secured to the sliding head—is increased over the ordinary type so that the extreme center to center distance of the outside puuches can be made 38 inches. The sliding head is made entirely of cast steel to give it sufficient rigidity and strength; punch holders and die blocks are also of this material. The illustration shows six punches and dies in position, but this number can be increased or diminished at pleasure, each punch having a separate gag so that it can be used independently of each of the others if desired. Another special feature in the construction of this machine is that

This tool will cover a very great range of work, both plate and structural, and is an extremely useful machine in any bridge or structural shop. Its capacity is equal to punching two 1-16 inch diameter holes through 1 inch thickness of iron at one stroke.

Clay Hollow Tiles for Bottle Racks.

ANOTHER article manufactured from clay has been added to the already long, but still extending, list of building materials. A useful as well as ornamental form of tile, to be used in the place of wooden racks for holding bottles, is shown in

the accompanying engraving, which is so self-explanatory that very little need be said about it. These tiles are manufactured by Henry Maurer & Son, 420 East Twenty-third street, New York. The tiles are laid up one above the other like a wall, which can be done by any bricklayer. They



are five inches by twelve inches outside measure, and are made of red clay, burned in the usual way. Air circulates freely about bottles held in these tile racks, enabling the contained liquids to be kept in perfect condition. As any bottle can be placed in position in, or removed from, the rack without disturbing any other bottle, risk of breakage is reduced to a minimum. Other advantages, which architects and builders will not fail to perceive, are economy of space, the rat- and vermin-proof character of the tile racks, and their durability, as compared with a wooden structure, especially in damp places, where wood is liable to decay. Four and one-half tiles occupy the space of one square foot, and the tiles are adapted to hold either pint or quart bottles.

American Machinery in the English Marine.

No better evidence of the high character of American hoisting and transporting machinery could be adduced than its adoption for, and use on, an English steamer. It is certain that any American appliance thus winning its way in the English marine must have fully demonstrated its superior fitness. The "Prince Edward," a new twin-screw passenger steamer recently built at Hull for the Dominion Atlantic Railway Company, to ply between Nova Scotia and Boston is a thoroughly up-to-date ship in all matters of equipment, and its outfit not only comprises the Lidgerwood Manufacturing Company's (New York) hoisting engines of the latest improved type, but also Temperley transporters for rapid handling of cargo, which device is exclusively manufactured and sold by the representative American company named.

Gold's Electric Heaters.

DURING the past few years the Gold Street Car Heating Company, New York, U. S. A., have been busily engaged in getting out a large number of different styles and sizes of electric heaters for street cars, houses, boats, buildings, etc., one of which is illustrated herewith.

This heater, we are informed, has found very considerable favor, and has atatined great success on a number of street railroads where it has been used. In this heater three resistance coils are run in a horizontal position and are securely held by enamelled plates. The cold air enters the heater at the bottom; and, on account of the peculiar mechanical construction of these heaters, this cold air is thoroughly cut up into atoms and heated before escaping through the opening at the top.

The principle of cutting up the air and bringing

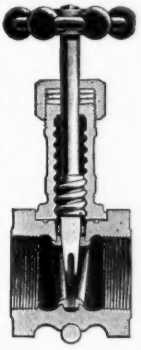
it in contact with the heated resistance wires is one that is very closely followed by the Gold Street Car Heating Company in all its designs of heaters, and on this account it is claimed that better results for less current are secured than is possible with any other electric heater on the market.

With the three coils in each heater, as shown, the use of a three-point switch enables three graduations of heat to be made in each car, so that passengers may be comfortably heated under any condition of

weather. It is claimed that with the Gold heaters perfect uniformity of heat in the car body is always maintained, and the floor of the car is always kept dry, the latter being a very valuable feature.

Lunkenheimer's Double-Seated "Clip" Gate Valve.

AN iron body, brass-mounted (or all iron) double-seated clip gate valve for one hundred pounds, working pressure, manufactured by The Lunkenheimer Company, Cincinnati, Ohio, U. S. A., is illustrated herewith.



This valve has been designed and manufactured to meet the demand for a simple, reliable, low priced valve, to stand the pressure named. Referrring to the engraving, it will be seen that the wedge shaped disc, which has two faces, is seated between bronze seat rings, which are permanently fastened in the iron valve body. This valve will take pressure from either end, and, not having any complicated interior mechanism, it can be placed in any position. The hub or bonnet of the valve is secured to the body by means of a round steel clip, which surrounds the body and passes through the lugs on sides of hub and is fastened by means of two nuts. This simple arrangement has the advantage over other means of connecting the parts of a valve, inasmuch as it permits of easy access to the interior at all times.

The joint between the hub and the body is indestructible, and consists of a seamless copper wire washer, partially imbedded in the top surface of the valve body, the portion which protrudes above said surface forming the joint against the under face of the hub when the two parts are connected.

Another valuable feature is the rapidity with which the disc can be raised from its seats. It requires only one-third as many turns of the hand wheel to open this valve full are is now required by other valves in the market. These valves are made of excellent materials, by the best workmanship. The bodies are rigid, to prevent any springing of the seats. The stuffing-box may be repacked, when the valve is either in the open or closed position.

The Mullins Embossed Sheet-Metal Duck-Boat.

REFERRING to our description of the Mullins embossed sheet-metal boats in this magazine for August, which gives a general idea of the way in which an entire line of boats manufactured by Mr. W. H. Mullins, of Salem, Ohio, U. S. A., are made by stamping into shape metal plates, subsequently riveted together to form a complete boat, we herewith illustrate a duck-boat so made, of especial interest now at the commencement of the duck-shooting season.

This boat is fitted with Standart's side-extension air chambers, and the carrying capacity of such a boat (fourteen feet long and forty-six inch beam weighing only ninety pounds, air-chambers and all) is shown without exaggeration in the picture. The extension canvas gunwale is very desirable when the hunter is liable to be caught out in very rough water. It is made to extend eight inches above deck, and prevents the waves from breaking over into the cockpit. It is made so as to be put up in a small roll and carried in the boat, and can be quickly attached to the boat should a storm arise.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Gould & Eberhardt, Newark, N. J., U. S. A. =(*a*) Illustrated pamphlet, describing Eberhardt's patent automatic gear cutters and automatic rack cutters, with directions for the use of these machines in cutting spur, bevel, miter- and worm-gears. (*b*) Illustrated pamphlet, or circular, of Eberhardt's patent drill press. (*c*) Nicely printed and illustrated pamphlet, entitled "Practical Hints for Cutting Spur, Bevel, Miter and Worm Gears"; containing, also, directions for using Eberhardt's patent automatic gear cutter, tables of cutters, and description of Eberhardt's patent cutter grinder. (*d*) Illustrated pamphlet, entitled Gear Cutter Cutters, and How to Grind Them." (*e*) Catalogue, illustrating and describing Eberhardt's patent shapers and various attachments. (*f*) Illustrated pamphlet, entitled "Cutting Tools and How to Grind Them." (*g*) Illustrated circular, of drop, foot-power, and screw presses and circular shears. (*h*) Small pamphlet, entitled "Like This," humorously illustrating and showing the folly of those who still sift sand for foundry purposes by hand, and setting forth the merits of Eberhardt's automatic sand-sifter.

Pickett & Sons, Atlas Locomotive Works, Bristol, England.=Small pamphlet of saddle-tank locomotives, with half-tone illustrations and concise data of dimensions, weight, and duties. Well printed on excellent paper.

Priestman Bros., Ltd., Hull and London.= Illustrated pamphlets. (*a*) The Priestman dredger, excavator, and elevator, in various sizes and mountings, for land and marine work, with reference to governments and contractors using the dredges. (*b*) The Priestman oil engine, for stationary and marine use. (*c*) The same, but exclusively in its marine applications.

Ransome, Sims & Jefferies, Ipswich and London.=(*a*) Illustrated catalogue and (*b*) illustrated price-list of steam engines and machinery, especially portable engines for coal and special fuels, semi-portable and fixed engines and boilers, compound engines, Corliss engines, vertical and wall engines, road locomotives, winching, hauling, and pumping machinery. Also (*c*) illustrated catalogue and (*a*) illustrated price-list of steam thrashing machinery, including many of the portable engines, and straw-trussers, stackers, and corn-mill machinery.

Frank Rippingille Stove Co., Ltd , Birmingham, England.=Large colored-covered catalogue, extensively illustrated, showing a great variety of stoves in all sizes, for all purposes and all fuels, with a supplementary discount sheet showing at a glance gross and net prices.

Simpson, Strickland & Co., Ltd., Dartmouth and Teddington-on-Thames, England.=Well printed and illustrated catalogue, in boards, devoted to machinery for steam launches and to light engines. Several introductory chapters are given to general points of launch building, design, and outfit. Descriptions of forty-five launch types, with dimensions, sections, and deck plans. Auxiliary leaflets are devoted to machinery for steam vans, and to a list of owners of launches and yachts built by this firm.

A. C. Wells & Co., 102-104 Midland road, London.=(*a*) Pamphlet describing the "Wells Light" and apparatus for producing a high illumination from oil for contractors' work, shipping, etc. (*b*) Filters for recovering waste oil. (*c*) "Lightning" painting machine (pneumatic). (*d*) "Industrial" oil lamps, for workshops, factories, etc. (*e*) Cast-metal "Unbreakable" lamps.

New Process Raw Hide Company, Syracuse, N. Y., U. S. A.=Catalogue illustrating and describing a line of "New Process" raw hide, noiseless solid raw hide spur, bevel, and friction gears, bushings, washers, etc., raw hide-bound mallets and chisel handles.

W. H. Mullins, Salem, Ohio.=Illustrated catalogue describing a line of stamped and embossed, sheet metal, pleasure and ducking boats made of galvanized steel, manganese bronze, or aluminum.

F. D. Winkley & Company, Madison, Wis., U. S. A.=Illustrated catalogue and price-list of Winkley's universal dust-proof oil-hole covers.

Marine Iron Works, Chicago, Ill., U. S. A.= (*a*) List of steam craft, new and second hand marine engines and boilers, on hand and for sale. (*b*) Circular addressed to excursion companies and boat-builders. (*c*) Illustrated descriptions of some of the steam craft built at this establishment.

The Railway Correspondence School, New York.=Circular describing the method and course of instruction.

The Waterbury Farrel Foundry & Machine Company, Waterbury, Conn., U. S. A.=Illustrated Catalogue (Section E.) describing foot, drop, and power presses.

Stewart Heater Company, Buffalo, N. Y., U. S. A.=(*a*) Illustrated, descriptive catalogue and price-list of power pump. (*b*) Illustrated, descriptive catalogue of tubular, sectional, and open feed-water heaters and purifiers.

Wm Inglis Wire & Iron Works, Detroit, Mich., U. S. A.=Catalogue. Section B, illustrating and describing wire heater-screens.

The J. D. Smith Foundry Supply Company, Cincinnati, Ohio, U. S. A.=Complete illustrated catalogue and price-list (No. 10) of foundry appliances and supplies.

University of Minnesota, Minneapolis, Minn., U. S. A.=Catalogue for the year 1896-1897, and announcements for the years 1897-1898.

Diamond Clamp & Flask Company, Richmond, Indiana, U. S. A.=Illustrated pamphlet, describing the "Diamond" brass dowel pins, wood fillets, steady pins, clamps, etc.

Millers Falls Company, New York.=Catalogue No. 25, illustrating and describing an extensive line of hardware goods, vises, bench tools, and sawing machines, manufactured by this company at Millers Falls, Mass., U. .S A.